NO. 22-2288

**IN THE UNITED STATES COURT OF APPEALS
FOR THE FEDERAL CIRCUIT**

APPLE INC.,
***Appellant*,**

v.

COREPHOTONICS, LTD.,
Appellee.

JOINT APPENDIX

Appeal from the United States Patent and Trademark Office, Patent Trial and Appeal Board in No. IPR2020-00489

RUSS AUGUST & KABAT

Marc A. Fenster
Neil A. Rubin
James S. Tsuei
12424 Wilshire Blvd.,12th Floor
Los Angeles, CA 90025
Tel: (310) 826-7474

Attorneys for Appellee Corephotonics, Ltd.

HAYNES AND BOONE, LLP

Debra J. McComas
Andrew S. Ehmke
2323 Victory Avenue
Suite 700
Dallas, Texas 75219
Phone: (214) 651-5375

David W. O'Brien
Hong Shi
600 Congress Avenue
Suite 1300
Austin, Texas 78701
Phone: (512) 867-8457

ADDITIONAL COUNSEL LISTED ON INSIDE COVER

Angela M. Oliver
800 17th Street NW
Suite 500
Washington, D.C. 20006
Phone: (202) 654-4552

Attorneys for Appellant Apple Inc.

INDEX

Paper/ Exhibit No.	Description	Pages
1024	Tamir Eshel, "IAI Unveils the Ghost – a Miniature UAV For Special Operations," August 8, 2011 ("Eshel")	Appx2602 - 2604
1026	NextVision MicroCam-D, https://www.aeroexpo.online/prod/nextvision-stabilized- systems/product-185740-28436.html ("NextVision MicroCam-D")	Appx3018 - 3023
1027	Fujinon Broadcast ENG series Fujinon A36 x 10.5 and A36 x 14.5 lenses ("Fujinon 36X Lenses")	Appx3024 - 3025
1028	Fujinon A36X14.5 BERD-R28 Ebay Listing, March 30, 2020, ("Fujinon 36X Lens Ebay Listing")	Appx3026
1030	UAS VISION, "Lightweight UAS Demand Accelerates Development of Lightweight Payloads," https://www.uasvision.com/2013/02/13/lightweight-uas-demand-accelerates-development-of-lightweight-payloads/, February 13, 2013 ("UAS VISION")	Appx3116 - 3122
1035	NextVision Stabilized Systems Ltd. Company Profile, September 02, 2012 ("NetVision Company Profile")	Appx3196
2003	Declaration of Duncan Moore, Ph.D.	Appx3229, 3242 - 3245, 3247 - 3251, 3256 - 3274
2005	Deposition transcript of José Sasián, November 9, 2020	Appx3387 - 3390
2006	José Sasián, Introduction to Lens Design (2019), hardcopy	Appx3486
2007	Tigran V. Galstian, Smart Mini-Cameras (2014)	Appx3500
2008	Dmitry Reshidko and Jose Sasián, "Optical analysis of miniature lenses with curved imaging surfaces," *Applied Optics*, Vol. 54, No. 28, E216-E223 (October 1, 2015)	Appx3507

Trials@uspto.gov
571-272-7822

Paper 32
Entered: July 26, 2021

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

APPLE INC.,
Petitioner,

v.

COREPHOTONICS, LTD.,
Patent Owner.

IPR2020-00489
Patent 10,015,408 B2

Before BRYAN F. MOORE, GREGG I. ANDERSON, and MONICA S. ULLAGADDI, *Administrative Patent Judges.*

ULLAGADDI, *Administrative Patent Judge.*

JUDGMENT
Final Written Decision
Determining No Challenged Claims Unpatentable
35 U.S.C. § 318(a)

I. INTRODUCTION

Apple Inc. (“Petitioner”) filed a Petition to institute an *inter partes* review of claims 5 and 6 (“the challenged claims”) of U.S. Patent No. 10,015,408 B2 (Ex. 1001, “the ’408 patent”). Paper 2 (“Pet.”). Corephotonics, Ltd. (“Patent Owner”) filed a Preliminary Response. Paper 7 (“Prelim. Resp.”).

We instituted an *inter partes* review of each of the challenged claims on the ground set forth in the Petition. Paper 8 (“Institution Decision” or “Inst. Dec.”). Patent Owner filed a Patent Owner Response (Paper 13, “PO Resp.”), and Petitioner filed a Petitioner Reply (Paper 18, “Pet. Reply”). Patent Owner thereafter filed a Sur-reply (Paper 20).

Oral arguments were heard on May 26, 2021, and a transcript has been entered into the record. Paper 31 (“Tr.”). Petitioner objected to various slides in Patent Owner’s demonstratives for the oral hearing (Paper 29) and Patent Owner similarly objected to various slides in Petitioner’s demonstratives (Paper 30).

Petitioner has the burden of proving unpatentability of the challenged claims by a preponderance of the evidence. 35 U.S.C. § 316(e) (2018). Having reviewed the parties’ arguments and supporting evidence, for the reasons discussed below, we determine that Petitioner has not demonstrated by a preponderance of the evidence that any of the challenged claims are unpatentable.

II. BACKGROUND

A. Related Proceedings

Petitioner and Patent Owner identify the following corresponding district court proceeding: *Corephotonics, Ltd. v. Apple Inc.*, Case No. 5:19-

cv-04809-LHK (N.D. Cal.). Pet. 1–2; Paper 6, 1.[1] Petitioner also notes the filing of a related *inter partes* review (IPR2020-00488) challenging claims 1–4 and 7 of the '408 patent. Pet. 2. We did not institute trial in that proceeding. IPR2020-00488, Paper 9 (decision denying *inter partes* review).

B. The '408 Patent

The '408 patent issued from an application that is a continuation of U.S. Application No. 14/880,251, filed on October 11, 2015, which is a continuation of U.S. Application No. 14/365,711, which was filed on June 16, 2014, and matured into U.S. Patent No. 9,185,291. Ex. 1001, code (63). U.S. Application No. 14/365,711 is an application under 35 U.S.C. § 371 of international patent application PCT/IB2014/062180, filed on June 12, 2014, and claims priority to U.S. Provisional Application No. 61/834,486, filed on June 13, 2013. *Id.* at code (60), 1:7–16.

The '408 patent concerns a dual-aperture zoom digital camera that operates in both still and video modes. *Id.* at code (57). The camera includes a Wide sub-camera and a Tele sub-camera, each of which includes a fixed focal length lens, an image sensor, and an image signal processor. *Id.* at 3:32–35. Figure 1A, reproduced below, illustrates a dual-aperture zoom imaging system, which is also referred to as a digital camera. *Id.* at 5:60–61, 6:18–20.

---

[1] Patent Owner cites *Corephotonics, Ltd. v. Apple Inc.*, Case No. **3**:19-cv-04809-LHK (N.D. Cal.) (Paper 6, 1), but this case number appears to reflect a typographical error. A PACER search of Case No. 5:19-cv-04809 reveals that Patent Owner's complaint in that case was likewise erroneously identified as "Civil Action No. 3:19-cv-4809" on its cover page.

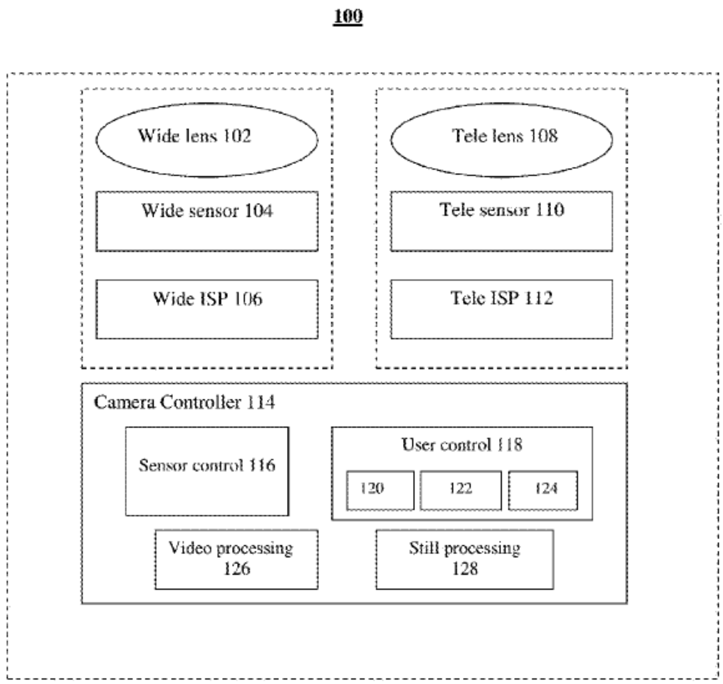


FIG. 1A

Figure 1A shows a dual-aperture zoom imaging system. *Id.*

In some embodiments, "the lenses are thin lenses with short optical paths of less than about 9mm" and "the thickness/effective focal length (EFL) ratio of the Tele lens is smaller than about 1." *Id.* at 3:39–41. These size specifications reflect the fact that "[h]ost device manufacturers prefer digital camera modules to be small, so that they can be incorporated into the host device without increasing its overall size." *Id.* at 1:31–33. An exemplary thin camera may use a lens block for the Tele lens, where the lens block may include five lens elements. *See id.* at 12:44–61. Figure 9, reproduced below, illustrates a lens block with first lens element 902 having positive power, second lens element 904 having negative power, third lens element 906 having positive power, fourth lens element 908 having negative power, and fifth lens element 910 having positive or negative power. *Id.* at 12:54–61.

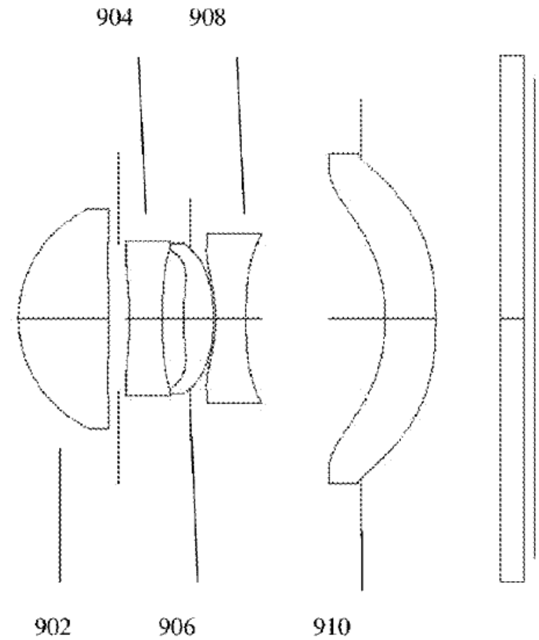


FIG. 9

Figure 9 shows a lens block in a thin camera. *Id.* at 6:12–13.

The ’408 patent discloses that in still mode, the camera performs zoom by either fully or partially fusing Wide and Tele images, where a fused image includes information from both Wide and Tele images. *Id.* at 3:44–49. In video mode, however, the camera performs optical zoom by switching between Wide and Tele images—i.e., without fusion—in order “to shorten computation time requirements, thus enabling high video rates.” *Id.* at 3:51–54. The invention uses the Wide sub-camera output for a low zoom factor (ZF) and the Tele sub-camera output for a high ZF. *Id.* at 11:13–29.

Normally, a user sees a jump, or discontinuous image change, when the camera switches between sub-camera output images. *Id.* at 10:37–39. The ’408 patent addresses this issue by employing a “smooth transition,” which “is a transition between cameras or [points of view] that minimizes the jump effect,” and which “may include matching the position, scale,

brightness and color of the output image before and after the transition." *Id.* at 10:39–45. Because "an entire image position matching between the sub-camera outputs is in many cases impossible," a smooth transition may achieve position matching "only in the [region of interest] while scale brightness and color are matched for the entire output image area." *Id.* at 10:45–52.

C. Challenged Claims

Petitioner challenges claims 5 and 6 of the '408 patent. Claim 5 is independent, and claim 6 depends from claim 5. Independent claim 5 is reproduced below.

> 5. A zoom digital camera comprising:
>
> a) a first imaging section that includes a fixed focal length first lens with a first field of view (FOV_1) and a first image sensor; and
>
> b) a second imaging section that includes a fixed focal length second lens with a second FOV (FOV2) that is narrower than FOV, and a second image sensor, wherein the second lens includes five lens elements along an optical axis starting from an object starting with a first lens element with positive power, wherein the five lens elements further include a second lens element with negative power, a fourth lens element with negative power and a fifth lens element, wherein a largest distance between consecutive lens elements along the optical axis is a distance between the fourth lens element and the fifth lens element, and wherein a ratio of a total track length (TTL) to effective focal length (EFL) of the second lens is smaller than 1.

Ex. 1001, 14:1–18.

D. Asserted Ground of Unpatentability

Petitioner challenges claims 5 and 6 as follows. *See* Pet. 11.

Claims Challenged	35 U.S.C. §	Reference(s)/Basis
5, 6	103	Golan[2], Kawamura[3, 4]

In support, Petitioner relies on the declaration of Dr. José Sasián (Ex. 1003).

III. ANALYSIS

A. Principles of Law

A claim is unpatentable under 35 U.S.C. § 103 if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). The question of obviousness is resolved on the basis of underlying factual determinations, including: (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of skill in the art; and (4) objective evidence of nonobviousness, i.e., secondary considerations. *See Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

"In an [*inter partes* review], the petitioner has the burden from the onset to show with particularity why the patent it challenges is

---

[2] U.S. Patent Application Publication No. 2012/0026366 A1, published Feb. 2, 2012 (Ex. 1005, "Golan").
[3] Japanese Patent Application Publication No. S58-62609, published Apr. 14, 1983 (Ex. 1007, "Kawamura").
[4] Petitioner asserts "Kawamura was published September 14, 2006, and issued December 20, 2011." Pet. 12. This appears to be a mistake because Kawamura is a published application—not an issued patent—with a publication date of April 14, 1983. Ex. 1007, codes (11), (12), (43).

unpatentable." *Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1363 (Fed. Cir. 2016) (citing 35 U.S.C. § 312(a)(3) (requiring *inter partes* review petitions to identify "with particularity . . . the evidence that supports the grounds for the challenge to each claim")). The burden of persuasion never shifts to Patent Owner. *See Dynamic Drinkware, LLC v. Nat'l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015) (citing *Tech. Licensing Corp. v. Videotek, Inc.*, 545 F.3d 1316, 1326–27 (Fed. Cir. 2008)) (discussing the burden of proof in an *inter partes* review). Furthermore, Petitioner cannot satisfy its burden of proving obviousness by employing "mere conclusory statements." *In re Magnum Oil Tools Int'l, Ltd.*, 829 F.3d 1364, 1380 (Fed. Cir. 2016).

B. Level of Ordinary Skill in the Art

Petitioner contends,

> a Person of Ordinary Skill in the Art ("POSITA") at the time of the claimed invention would have a bachelor's degree or the equivalent degree in electrical and/or computer engineering, physics, optical sciences or a related field and 2–3 years of experience in imaging systems including optics and image processing.

Pet. 8–9. Petitioner supports its contention with the testimony of Dr. Sasián. Ex. 1003 ¶ 20.

Patent Owner argues that "[a] person of ordinary skill in the art (POSITA) of the '408 patent, at the time of the effective filing date, would have possessed an undergraduate degree in optical engineering, electrical engineering, or physics, with the equivalent of three years of experience in optical design." PO Resp. 12–13. Patent Owner supports its contention with the testimony of Dr. Duncan Moore. Ex. 2003 ¶ 14. Patent Owner

further contends that "the effective filing date of the '408 patent is June 13, 2013," and that "Apple's expert Dr. Sasián appears to have applied the date of June 13, 2013 in his analysis of the level of ordinary skill as well." PO Resp. 13 (citing Ex. 1003 ¶ 19).

The parties do not appear to dispute the effective filing date of the challenged claims and each rely on June 13, 2013, the earliest claimed priority date of the '408 patent, as the effective filing date in making their respective arguments. Accordingly, we determine the level of ordinary skill in the art as of this date. However, if the '408 patent is not entitled to the filing date of the provisional application from which it claims priority and is, instead, entitled to a *later* date, this would not alter the conclusions rendered in this Decision.

Neither party argues that the level of ordinary skill is dispositive of any issue. Further, we do not discern significant differences between the parties' definitions. The conclusions rendered in this Decision do not turn on selecting a particular definition for the level of ordinary skill. We determine that the level of ordinary skill in the art proposed by Petitioner is consistent with the '408 patent and the asserted prior art and as such, we adopt and apply Petitioner's proposal.

C. Claim Construction

For *inter partes* reviews filed on or after November 13, 2018, we apply the same claim construction standard used by Article III federal courts and the International Trade Commission, both of which follow *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (en banc), and its progeny. *See* 37 C.F.R. § 42.100(b); Changes to the Claim Construction Standard for Interpreting Claims in Trial Proceedings Before the Patent Trial and Appeal

Board, 83 Fed. Reg. 51,340, 51,341 (Oct. 11, 2018). Accordingly, we construe each challenged claim of the ’408 patent to generally have “the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent.” 37 C.F.R. § 42.100(b).

Petitioner proposes a construction for one limitation, as discussed in detail below. Pet. 9–11. Patent Owner disagrees with Petitioner’s proposed construction, as further detailed below. *See* Prelim. Resp. 15–17; PO Resp. 13–16.

“smooth transition”

Dependent claim 6 recites “the camera controller configured to provide video output images with a smooth transition when switching between a lower zoom factor (ZF) value and a higher ZF value or vice versa.” Ex. 1001, 14:21–24.

Petitioner contends “a POSITA would have understood . . . ‘*smooth transition*’ to mean ‘transition with a reduced discontinuous image change,’ for example, a transition with a continuous image change.” Pet. 10 (citing Ex. 1003 ¶¶ 44–47). Petitioner asserts the Specification supports this proposed construction. *Id.* at 10–11. In our Institution Decision, we rejected Petitioner’s proposed construction and preliminarily concluded that “smooth transition” means “a transition between cameras or points of view that minimizes the jump effect.” Inst. Dec. 11. In its Petitioner Reply, Petitioner asserts that

> [i]n the context of claim 6 of the subject ’408 Patent, the language of “a transition between cameras or points of view” in the construction for “smooth transition” is redundant and unnecessary, because claim 6 itself provides “*a smooth transition when switching between a low zoom factor (ZF) value and a*

> *higher ZF value or vice versa*." Given the language of the claim, Petitioner's proposed construction is entirely consistent with that adopted in the Institution Decision, and Petitioner's analysis applies to either construction.

Pet. Reply 2 (citing Ex. 1001, 14:22–24; Ex. 1013 ¶¶ 4–5).

Patent Owner disputes Petitioner's proposed construction for "smooth transition." PO Resp. 13–16. Patent Owner contends that "the term 'smooth transition' should be construed as 'a transition that minimizes the jump effect such that there is no jump in the ROI region.'" *Id.* at 16 (citing Ex. 2003 ¶ 44). This is a shift from its position in its Preliminary Response in which Patent Owner contends that "'smooth transition' should be construed as it was for the '291 patent: 'a transition between cameras or POVs that minimizes the jump effect.'" Prelim. Resp. 17. We point out this contention from the Preliminary Response to highlight the fact that Patent Owner's earlier proposed construction was an agreed-to construction from a district court litigation for related U.S. Patent No. 9,185,291.[5] *See* Prelim. Resp. 15–17; Ex. 2001, 2 (Joint Claim Construction and Prehearing Statement).

Based on our review of the complete record developed at trial, we conclude that our resolution of Petitioner's asserted ground of unpatentability does not turn on the construction of "smooth transition" or any other claim term. *Infra* §§ III.D.3–III.D.4. As such, we need not expressly construe "smooth transition" or any other claim term to resolve the dispute between the parties, and therefore, we do not expressly define any claim term. *See Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017) (explaining that construction is needed

[5] The '408 patent claims priority to the '291 patent. *See* Ex. 1001, code (63).

only for terms that are in dispute, and only as necessary to resolve the controversy).

D. Obviousness over Golan and Kawamura

Petitioner contends that claims 5 and 6 are unpatentable as obvious under 35 U.S.C. § 103 over Golan and Kawamura. Pet. 13–56. For the reasons that follow, we determine that the evidence does not sufficiently support Petitioner's arguments, and thus Petitioner does not establish the unpatentability of claims 5 and 6 by a preponderance of the evidence.

1. Overview of Golan (Ex. 1005)

Golan concerns a "method for continuous electronic zoom in a computerized image acquisition system," in which the system has "a wide image acquisition device and a tele image acquisition device." Ex. 1005, code (57). By providing "multiple image devices each with a different fixed field of view (FOV)," Golan's system "facilitates a light weight electronic zoom with a large lossless zooming range." *Id.* ¶ 9. Golan's Figure 1, reproduced below, illustrates a zoom control sub-system for an image acquisition system. *Id.* ¶ 26.

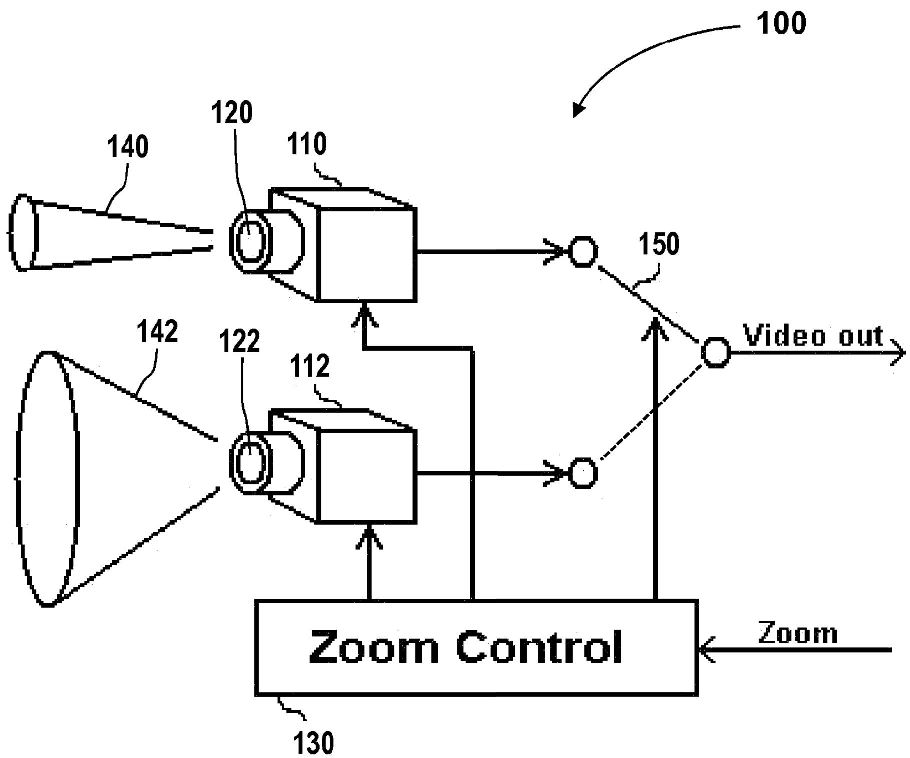


Fig 1

Figure 1 of Golan illustrates a zoom control sub-system for an image acquisition system. *Id.*

According to Golan, "[z]oom control sub-system 100 includes a tele image sensor 110 coupled with a narrow lens 120 having a predesigned FOV 140, a wide image sensor 112 coupled with a wide lens 122 having a predesigned FOV 142, a zoom control module 130 and an image sensor selector 150." *Id.* ¶ 37. The zoom control module 130 selects a relevant image sensor through image sensor selector 150 and calculates a relevant camera zoom factor when it receives a required zoom from an operator. *Id.* ¶ 39. Golan's system facilitates "continuous electronic zoom capabilities

with uninterrupted imaging," which "is also maintained when switching back and forth between adjacently disposed image sensors." *Id.* ¶ 40.

2. *Overview of Kawamura (Ex. 1007)*

Kawamura concerns a "Telephoto Lens." Ex. 1007, code (54). Kawamura's lens is a "medium telephoto lens" that has, "for example, a lens of a focal length of about 200 mm for a screen size of 6x7 or a focal length of about 150 mm for a screen size of 4.5x6." *Id.* at 1. The lens "keeps a compactness of an overall length to a conventional level of a telephoto ratio of about 0.96 to 0.88 but has an excellent image-formation performance due to favorably correcting spherical aberration of both a reference wavelength and color and also decreasing chromatic aberration in magnification." *Id.* Kawamura's Figure 1, reproduced below, illustrates one example of a lens system configuration. *Id.* at 5–6.

FIG. 1

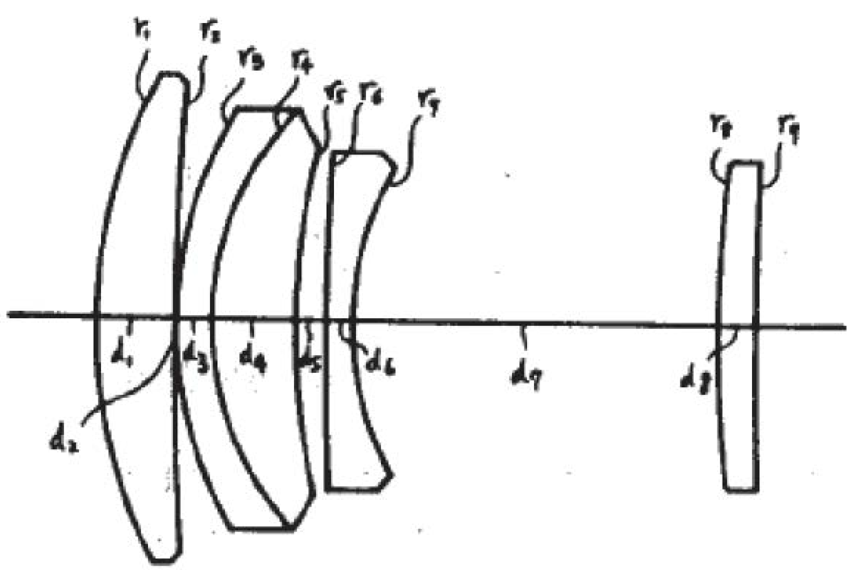


Figure 1 of Kawamura illustrates one example of a lens system configuration. *Id.*

According to Kawamura, the inventive lens, including the example shown in Figure 1, is

> a telephoto lens of a four-group, five-lens configuration of, in order from an object side, a first lens, which is a positive meniscus lens that is convex toward an object side; a second lens and a third lens, which are a laminated positive meniscus lens of a negative meniscus lens and a positive meniscus lens having a lamination surface that is convex toward the object side; a fourth lens, which is a negative lens having a rear surface with a large curvature that is concave toward an image-surface side; and a fifth lens, which is a positive lens.

Id. at 1–2.

3. Analysis of Independent Claim 5

Patent Owner does not contest Petitioner's showing that the combination of Golan and Kawamura teaches or suggests the following limitations of claim 5, but argues that Petitioner has failed to show that it would have been obvious to combine these references as set forth in the Petition. *See generally* PO Resp. We summarize Petitioner's contentions for each claim limitation to provide context for our findings and conclusion with respect to Petitioner's rationale for combining. As explained below, we agree with Patent Owner that Petitioner has failed to show that it would have been obvious to combine Golan and Kawamura.

a) Petitioner's Element-by-Element Contentions

"A zoom digital camera comprising:"

Petitioner contends that, to the extent the preamble of independent claim 5 is limiting, Golan teaches a zoom digital camera. Pet. 23. Specifically, Petitioner argues Golan's Figure 1 embodiment discloses zoom

control sub-system 100 that includes "a tele image sensor 110 coupled with a narrow lens 120 having a predesigned FOV 140, a wide image sensor 112 coupled with a wide lens 122 having a predesigned FOV 142, a zoom control module 130 and an image sensor selector 150." *Id.* at 24 (quoting Ex. 1005 ¶ 37) (emphasis omitted). Petitioner explains that "[i]n Golan's zoom control sub-system 100, each of the Wide imaging device (including wide image sensor 112 and wide lens 122) and the Tele imaging device (including tele image sensor 110 and narrow lens 120) defines an aperture for generating a corresponding digital image." *Id.* at 25 (citing Ex. 1003 ¶ 68). Accordingly, Petitioner asserts, "Golan's image acquisition system including a zoom control sub-system 100 is a digital camera providing digital zoom." *Id.*

"a first imaging section that includes a fixed focal length first lens with a first field of view (FOV_1) and a first image sensor"

Petitioner contends that Golan teaches the first imaging section of independent claim 5. Pet. 25–29. Specifically, Petitioner argues Golan discloses "a first imaging section that includes a wide lens 122 (first lens) with a FOV 142 (a first field of view (FOV_1)) and a wide image sensor 112 (first image sensor)." *Id.* at 25 (citing Ex. 1005 ¶¶ 36–37, Fig. 1). Petitioner asserts that Golan's wide lens 122 has a predesigned field of view that is fixed, and it is thus a fixed focal length lens. *See id.* at 26–29 (citing Ex. 1003 ¶¶ 72–73, 75–78; Ex. 1005 ¶¶ 9, 36–37, 43; Ex. 1016, 48).

> *"a second imaging section that includes a fixed focal length second lens with a second FOV (FOV2) that is narrower than FOV, and a second image sensor"*

Petitioner contends that Golan teaches the second imaging section of independent claim 5. Pet. 30–32. Specifically, Petitioner argues Golan discloses "a second imaging section that includes a tele image sensor 110 (second sensor) coupled with a narrow lens 120 (a fixed focal length second lens) having a predesigned FOV 140 (second FOV (FOV_2))." *Id.* at 30 (citing Ex. 1003 ¶ 79; Ex. 1005 ¶¶ 36–37, Abstract, Fig. 1). For reasons similar to those discussed with respect to Golan's wide lens 122, Petitioner asserts Golan's narrow lens 120, with a predesigned field of view, is a fixed focal length lens. *Id.* at 31 (citing Ex. 1003 ¶ 80; Ex. 1005 ¶¶ 9, 36–37, 43). Petitioner further asserts that Golan discloses "a FOV 140 (FOV_2) of the narrow lens 120 that is narrower than FOV 142 (FOV_1) of the wide lens 122." *Id.* (citing Ex. 1003 ¶ 81). In particular, Petitioner points to Golan's disclosure that "[p]referably, wide FOV 142 is substantially wider than narrow FOV 140." *Id.* (quoting Ex. 1005 ¶ 43) (emphasis omitted).

> *"wherein the second lens includes five lens elements along an optical axis starting from an object starting with a first lens element with positive power, wherein the five lens elements further include a second lens element with negative power, a fourth lens element with negative power and a fifth lens element"*

Petitioner contends that the combination of Golan and Kawamura renders obvious the lens element arrangement of the second lens of independent claim 5. Pet. 32–37. Specifically, Petitioner argues that Kawamura discloses a number of examples of a fixed focal length tele lens

having five lens elements as arranged in the claim. *Id.* at 33 (citing Ex. 1003 ¶ 84). Petitioner asserts Kawamura's Figure 1 shows five lens elements, which Petitioner labels L1–L5, where L1 is a positive meniscus lens; L2 and L3 are respective negative and positive meniscus lenses and are combined to form a laminated positive meniscus lens; L4 is a negative lens; and L5 is a positive lens. *Id.* at 33–36 (citing Ex. 1003 ¶¶ 85–89; Ex. 1007, 1, 5, Fig. 1).

> *"wherein a largest distance between consecutive lens elements along the optical axis is a distance between the fourth lens element and the fifth lens element" and*
>
> *"wherein a ratio of a total track length (TTL) to effective focal length (EFL) of the second lens is smaller than 1"*

Petitioner contends the combination of Golan and Kawamura renders obvious the independent claim 5 feature of a largest distance between consecutive lens elements being between the fourth and five lens elements. Pet. 37–41. Petitioner argues that Kawamura's Figure 1 shows that the distance d7 between the lenses Petitioner labels as L4 and L5 is the largest distance among all the respective distances between consecutive lenses in Figure 1. *Id.* at 38–40 (citing Ex. 1003 ¶¶ 95–97; Ex. 1007, 3).

Petitioner further contends that the combination of Golan and Kawamura renders obvious the total track length to effective focal length ratio feature of independent claim 5. *Id.* at 41–44. Petitioner argues that "Kawamura's telephoto lens 'keeps a compactness of an overall length to a conventional level of a telephoto ratio of about 0.96 to 0.88.'"" *Id.* at 41 (quoting Ex. 1007, 1) (citing Ex. 1003 ¶ 103). Petitioner further argues that "[a] POSITA would have understood that a telephoto ratio of Kawamura is a

ratio of total track length (TTL)/effective focal length (EFL)." *Id.* (citing Ex. 1003 ¶ 103; Ex. 1006, 169).

b) Rationale for Combining Golan and Kawamura

Petitioner presents two alternative theories—a first alternative theory in which scaling is not involved in the combination of Golan and Kawamura and a second alternative theory in which the combination involves scaling. *See* Pet. 20–23.

(1) Petitioner's Contentions in the Petition Regarding its First Alternative Theory

Petitioner contends that a person of ordinary skill in the art would have been motivated to apply Kawamura's teachings to Golan "to produce the obvious, beneficial, and predictable results of a digital camera including a tele lens with a compactness of an overall length while having an excellent image-formation performance as taught by Kawamura." Pet. 20 (citing Ex. 1003 ¶¶ 60–64). Petitioner supports its contention by arguing that "Golan recognizes that a typical camera with a large dynamic zoom range 'requires heavy and expensive lenses, as well as complex design,' and has a goal to provide an imaging device with 'light weight' electronic zoom." *Id.* at 21 (quoting Ex. 1005 ¶¶ 7–8). Petitioner further contends that "Golan recognizes the need to provide excellent image quality by providing 'lossless electronic zoom' for maintaining the desired resolution and by providing 'continuous electronic zoom with uninterrupted imaging.'" *Id.* (quoting Ex. 1005 ¶ 4, Abstract) (citing Ex. 1003 ¶ 62). Petitioner also contends that Kawamura addresses these needs identified in Golan by providing "a telephoto lens that 'keeps a compactness of an overall length to a conventional level of a telephoto ratio of about 0.96 to 0.88 but has an

excellent image-formation performance.'" *Id.* (quoting Ex. 1007, 1) (citing Ex. 1003 ¶ 62) (emphases omitted). The resulting system, Petitioner argues, "would have been no more than the combination of known elements according to known methods (such as modifying the tele lens 120 in [the] zoom control subsystem of Golan according to Kawamura's teachings). . . ." *Id.* at 22. Dr. Sasián testifies that "combining the teachings of Kawamura with the system of Golan would have produced operable results that are predictable." Ex. 1003 ¶ 63.

(2) Petitioner's Contentions in the Petition Regarding its Second Alternative Theory

Petitioner alternatively contends that "[t]o the extent that modifications would have been needed in order to accommodate the teachings of Kawamura in the system of Golan," "a POSITA would have scaled the Kawamura lens prescriptions to fit into a digital camera of Golan . . . ." Pet. 22–23. Specifically, Dr. Sasián testifies that "lens scaling was a well-known practice in lens design, and a POSITA would have scaled the Kawamura lens prescriptions to fit into a digital camera of Golan while maintaining the compactness and an excellent image-formation performance." Ex. 1003 ¶ 64 (citing Ex. 1006, 57; Ex. 1009, 254–355). The cited evidence includes "Modern Lens Design: A Resource Manual," by Warren J. Smith (Ex. 1006), and "ZEMAX Optical Design Program User's Manual" (Ex. 1009). *See* Ex. 1006, 57 (discussing how "[a] lens prescription can be scaled to any desired focal length simply by multiplying all of its dimensions by the same constant" and that "[a]ll of the *linear* aberration measures will then be scaled by the same factor"); Ex. 1009, 254–255 (with respect to "scale lens," stating that "scale will scale the entire lens

by the specified factor," and that "[t]his useful for scaling an existing design to a new focal length, for example.").

c) Patent Owner Contentions Regarding Petitioner's Rationale for Combining

Patent Owner contends that a person of ordinary skill in the art would not have been motivated to combine Golan and Kawamura. PO Resp. 32–53.

With respect to Petitioner's first alternative theory that combining Golan and Kawamura does not require scaling, Patent Owner argues "the goal in Golan was to avoid 'heavy and expensive lenses' and to achieve 'light weight electronic zoom.'" *Id.* at 32 (Ex. 1005 ¶¶ 7–9). Patent Owner further contends that, "[i]n the context of camera design, the 7-inch Kawamura lenses would have been considered 'heavy,' both in 1981 when Kawamura was filed and in 2009 on Golan's asserted priority date."[6] *Id.* (Ex. 2003 ¶ 74). Patent Owner bases its position on "the fact that Golan contemplates use of 5 megapixel digital sensors," which it asserts "commonly had dimensions of 2.7 mm x 3.6 mm or 3.6 mm x 4.8 mm, [which are] much smaller than the 56 mm x 67 mm film size Kawamura's lenses were designed for." *Id.* at 33 (citing Ex. 2003 ¶ 75; Ex. 2007, 4).

---

[6] Patent Owner's reference to 2009 as the relevant time frame for the obviousness analysis appears to be in error. The face of the '408 patent shows a provisional application filed on June 13, 2013. Ex. 1001, code (60); *compare id.*, *with* Ex. 2003, 15 (Dr. Moore relying on June 13, 2013, as the effective filing date). As explained above, we do not expressly determine the priority date for the '408 patent to render the conclusions in this Decision. We rely on June 13, 2013, as the earliest *possible* priority date for the '408 patent.

With respect to Petitioner's second alternative theory that the combination of Golan and Kawamura involves scaling Kawamura's lens assembly, Patent Owner contends that "scaling [a lens] design will also scale the aberrations of the design and leave many dimensionless properties of the lens design unchanged[;] that does not does not mean that the resulting design will be practical or useful." *Id.* at 34–35 (citing Ex. 2003 ¶ 78). Patent Owner supports its position in part with an article titled "Optical Analysis of Miniature Lenses with Curved Imaging Surfaces" co-authored by Dr. Sasián and his student Dmitry Reshidko, which discloses that "[a] traditional objective lens can not [sic] be simply scaled down as a lens solution due to fabrication constraints, materials['] properties, manufacturing process[es], light diffraction and geometrical aberrations." *Id.* at 35–36 (quoting Ex. 2008, 1). Patent Owner also points to the Ph.D. dissertation of Dr. Sasián's student Yufeng Yan, which according to Patent Owner discloses

> "that the design approaches and lens constructions are significantly different between a miniature camera lens and a conventional camera lens" and that "if the conventional camera lens was simply scaled down to the same focal length of the miniature lens, it would encounter many issues." Yan further explained: "[s]caling down a conventional camera lens requires spatial tolerances to scale down with the same ratio, which is about the factor of 7. This creates a huge problem on the tolerance budget of element and surface decenter."

PO Resp. 36–37 (quoting Ex. 2013, 79, 83).

Patent Owner also cites to a Society of Photo-optical Instrumentation Engineers (SPIE) article by Bareau et al., "The Optics of Miniature Digital Camera Modules" (Ex. 2012, "Bareau"). *Id.* at 37 (citing Ex. 2012, 1, 3). Bareau was cited in a textbook authored by Dr. Sasián, "Introduction to Lens Design" (Ex. 2006, 195), and relied upon by Petitioner in another

proceeding challenging another patent assigned to Patent Owner (IPR2018-01146, Ex. 1012) in which Dr. Sasián provided expert testimony. Bareau discloses that

> When designing a camera module lens, it is not always helpful to begin with a traditional larger-scale imaging lens. Scaling down such a lens will result in a system that is unmanufacturable. . . . For glass elements, the edge thicknesses will become too thin to be fabricated without chipping. To achieve a successful design we have to modify our lens forms and adjust the proportions of the elements.

Ex. 2012, 1.

d) Petitioner's Responsive Contentions Regarding its Reasons for Combining

First, Petitioner argues that Golan's teachings are not limited to miniature cameras or sensors such as those used in mobile devices and thus, would have been understood by a POSITA to "apply to imaging systems of various sizes using any suitable image sensors." Pet. Reply 8 (citing Ex. 1013 ¶ 16) (arguing Golan's teachings also "include applications for conventional digital still cameras and other commercial, industrial and security applications including air-born vehicles/drones applications"). In support of its position that Golan's teachings "do[] not establish a dimension limitation on either its imaging system or image sensors," Petitioner cites to products and patents of the inventors and the assignee of Golan, NextVision Stabilized Systems, Ltd. ("NextVision"), that purportedly "confirm" "the applicability of Golan's teachings to applications beyond the mobile device realm." Pet. Reply 8.

Second, Petitioner argues that

> Patent Owner's arguments should be rejected because they improperly rely on Golan's example 5-Megapixel image sensor

> as a requirement, because they fail to recognize that a POSITA would have used other sensors (e.g., of different megapixel number or different dimensions) in Golan's systems, and because scaling to accommodate a sensor size was practical and with the skill of a POSITA, as demonstrated by Dr. Sasián.

Id. at 10 (citing Ex. 1013 ¶ 18). Petitioner further characterizes Patent Owner's expert's testimony as "admit[ting] that lightweight cameras may be used in applications including drones, endoscope applications, and space applications, without using miniature lenses as defined in the context of cellphone." *Id.* at 13 (citing Ex. 1017, 143:16–145:19, 148:16–19).

Third, Petitioner argues that a "POSITA would have understood that, in Golan, the terms 'heavy,' 'expensive,' and 'light weight' are relative." *Id.* at 13 (citing Ex. 1013 ¶ 25). Petitioner explains that

> Golan describes that a camera with a single optical zoom lens having a large dynamic zoom range typically requires "heavy and expensive lenses." An example of such a heavy and expensive lens is a Fujinon A36X14.5 lens, an optical zoom lens providing a zoom ratio of 36x. The Fujinon A36X14.5 lens is heavy with a weight of 4.58kg (about 10 pounds) and a length of 363.3 mm (about 14.3"), and is expensive (e.g., a used one priced on eBay for over $10,000).
>
> . . . .
>
> . . . [C]ompared to a camera with a single Fujinon A36X14.5 lens, according to Golan's teachings, a POSITA could and would have achieved light weight digital zoom of 36x by using a wide lens and a telephoto lens (e.g., based on Kawamura's lens design) that are cheaper and lighter than the Fujinon A36X14.5 lens. As such, Golan does not require using 1/4" or 1/3" miniature digital sensors to achieve a cheaper lightweight digital zoom.

Pet. Reply 12–13 (Ex. 1005 ¶ 7; Ex. 1028, 1; Ex. 1027, 1; Ex. 1013 ¶ 23).

Fourth, Petitioner contends that "Patent Owner's analysis is incorrect because it is based on a POSITA's understanding of technology in 1981 and incorrect understanding of ongoing relevance of older lens designs." *Id.* at 20 (emphasis omitted). Petitioner characterizes Patent Owner's argument as "imply[ing] that designs from 1981 would be wholly outdated by 2013," and asserts that "lens designs remain relevant designs to a POSITA for many decades." *Id.* at 21 (citing Ex. 1013 ¶ 39; Ex. 1025, 359–366 (textbook titled "Modern Lens Design" from 2005 allegedly including example telephoto lens designs from 1950, 1977, and 1982)). Petitioner further argues that "[b]ecause Patent Owner incorrectly relies on a[] POSITA's knowledge of the technology in 1981, [Patent Owner] fails to consider the ongoing relevance of older lens designs with modern lens design, and fails to evaluate prior art as a POSITA at the time the invention was made . . . ." *Id.*

e) Analysis of Rationale for Combining

For the reasons that follow, we determine that Petitioner's rationale for combining Golan and Kawamura, under either its first alternative theory or its second alternative theory, is not supported by sufficient rational underpinning.

(1) Petitioner's First Alternative Theory Without Scaling

We are not persuaded that Petitioner's evidence sufficiently supports its rationale for combining Golan and Kawamura and a finding that one of ordinary skill in the art at the time of the earliest priority date *of the '408 patent* would have understood Kawamura's lens assembly to have "compactness of an overall length" such that Kawamura's lens assembly would have been understood to address the needs identified in Golan and its

"goal to provide an imaging device with '*light weight*' electronic zoom," as Petitioner contends. Pet. 20–21 (quoting Ex. 1005 ¶¶ 7–8; Ex. 1007, 1) (citing Ex. 1003 ¶¶ 60–64) (emphases added).

With regard to Petitioner's *first* argument, there is insufficient evidence of record to support the proposition that Golan's teachings are applicable to imaging systems that are of a scale larger than that of the miniature cameras and image sensors used in mobile devices. According to Petitioner, a "POSITA's understanding of the applicability of Golan's teachings to applications beyond the mobile device realm is confirmed by other disclosures from Golan's inventors and assignee, NextVision. . . ." Pet. Reply 8 (citing Ex. 1013 ¶ 17). Petitioner then cites exhibits and patents purporting to show products of the assignee of Golan, NextVision. Pet. Reply 8–9 (citing Exs. 1022, 1024, 1026, 1030, 1034, 1035). Dr. Sasián's testimony in paragraph 17 of his Reply Declaration also relies on these exhibits and patents. Ex. 1013 ¶ 17; *see id.* ¶¶ 21, 28 (citing Exs. 1029, 1031, 1032).

As an initial matter, the fact that the assignee of the Golan reference produces products having imaging systems of varying sizes does not, without more, suggest that Golan's teachings, specifically, are applicable to these products or vice versa.[7] *Cf. Abbott Labs. v. Dey, L.P.*, 287 F.3d 1097, 1104 (Fed. Cir. 2002) (finding the relationship between

[7] We do not discern that an assignee's products would be relevant to the scope of a patent that is not asserted to cover those products and does not discuss those products in its specification. *Cf. See Astrazeneca AB v. Mut. Pharm. Co.*, 384 F.3d 1333, 1340 (Fed. Cir. 2004) (discussing disavowal of claim scope through criticism of other products in the general summary or description of the invention).

two unrelated patents, although having common subject matter, a common inventor, and ***the same assignee***, "insufficient to render particular arguments made during prosecution of [one of the patents] equally applicable to the claims of [the other patent]"). In fact, these exhibits regarding NextVision's products do not sufficiently establish—either alone or in combination with Dr. Sasián's testimony—that a person of ordinary skill in the art would have understood from the exhibits that Golan's teachings apply to image sensors, imaging systems, and lens assemblies of all sizes.

Dr. Sasián's reliance on the exhibits is conclusory. *See, e.g.*, Ex. 1013 ¶¶ 16, 17, 21, 28. Dr. Sasián's testimony regarding the exhibits simply lists them, describes their subject matter, and concludes that they confirm "the applicability of Golan's teachings to applications other than only mobile devices . . . ." *Id.* ¶ 17. Below we provide a summary of the references relied on by Petitioner and Dr. Sasián in order to support our finding that none of the exhibits adequately support Petitioner's contentions and Dr. Sasián's testimony as to Golan and its purported applicability to image sensors, imaging systems, and lens assemblies of all sizes.

Exhibit 1022 is U.S. Patent No. 8,896,697 B2 to Golan et al. ("Golan '697") and is titled "Video Motion Compensation and Stabilization Gimbaled Imaging System." Ex. 1022, codes (76), (54). Golan '697 discloses as its field of invention "an imaging system, operatively mounted on an air-born vehicle, that can transmit high resolution images of a selected region of interest, whereas the images are continuously compensated for vehicle motion." *Id.* at 1:14–18.

Exhibit 1024 is an article titled "IAI [(Israel Aircraft Industries)] Unveils the Ghost – a Miniature UAV [(Unmanned Aerial Vehicle)] For

Special Operations" by Tamir Eshel dated August 8, 2011 ("Eshel"). It depicts "twin rotors [that] create adequate lift within a relatively small diameter (0.75 cm/2.46 ft), enabling the Ghost [UAV] to navigate safely near obstacles, enter through windows and hover inside built-up areas or penetrate dense vegetation." Ex. 1024, 1–2.

Exhibit 1026 is a screen capture of NextVision's website and product MicroCam-D, an aerial photography camera. Ex. 1026, 1. It describes MicroCam-D as being 4.6 ounces and capable of performing digital zoom. *Id.* at 2. It also includes images of other NextVision products such as drone detection cameras, optical emission cameras, and other aerial photography cameras. *Id.* at 3–5.

Exhibit 1029 is a product manual for Kodak's EasyShare V610 dual lens digital camera ("Kodak EasyShare") which Dr. Sasián cites to show that "[a] POSITA would have understood that image sensors of different dimensions, for example, a 1/2.5" sensor, may be used in Golan," and contends that Kodak EasyShare has "a dual lens digital camera to provide a 5.3-megapixel image." Ex. 1013 ¶ 21.

Exhibit 1030 is an article from a global news service, Unmanned Aircraft Systems (UAS) Vision, titled "Lightweight UAS Demand Accelerates Development of Lightweight Payloads." The article describes how the "near future . . . will see smaller payloads achieved within radar[,] laser[,] and thermal systems" on the order of less than 100 grams. Ex. 1030, 3. The article expresses that such developments "are causing a change in the operational concept of UAS." *Id.*

Exhibit 1031 is U.S. Patent No. 8,462,209 B2 to Sun and is titled "Dual-swath Imaging System" ("Sun"). It discloses "[a] portable, aerial,

dual-swath photogrammetric image system comprising twin nadir pointing CCD cameras for simultaneously acquiring twin adjacent digital images for merging into a large panorama." Ex. 1031, codes (54), (57). Sun further discloses "a first lens shift mount . . . for physically shifting [a] first large format optical lens" and "a second lens shift mount . . . for shifting the focal point of said second large format optical lens . . . ." *Id.* at 10:32–38, 10:47–54.

Exhibit 1032 is U.S. Patent No. 7,974,460 B2 to Elgersma and is titled "Method and System for Three-dimensional Obstacle Mapping for Navigation of Autonomous Vehicle" ("Elgersma"). Ex. 1032, code (54). Elgersma discloses "an autonomous vehicle with an image capturing device, and focusing the image capturing device at a predetermined number of different specified distances to capture an image at each of the specified distances." *Id.* at code (57). Dr. Sasián cites Sun and Elgersma in support of the testimony that "a POSITA would have used image sensors of various dimensions, including sensors with sizes similar to a film size of Kawamura, that are suitable for applications," specifically, unmanned aerial vehicles. Ex. 1013 ¶ 28 (citing Ex. 1031, 2:31–45; Ex. 1032, 1:10, 1:25–26).

Exhibit 1034 is a video capture showing navigation to and through NextVision's website as of September 2, 2012, using the Internet Archive's Wayback Machine. The video capture shows footage shot by NextVision's MicroCam-D product. The video appears to show the MicroCam-D camera zooming in on targets and is annotated with the caption "digital zoom" at various points, in particular, at approximately 1:45 minutes.

Exhibit 1035 is a screen capture of a profile for NextVision describing the company as privately owned and "focusing on development and

production of Electro-Optical stabilized payload and solid state digital cameras for day and night observation." Ex. 1035, 1. It describes NextVision's MicroCam-D product as the world's first sub 100-gram, gyro-stabilized payload. *Id.*

Petitioner does not point to any portion of these exhibits that mentions Golan or the invention described therein. *See generally* Pet. Reply. Nor does Petitioner point to evidence that sufficiently addresses the applicability of Golan's specific teachings to any particular product or imaging system described in the cited exhibits. *Id.* Dr. Sasián's Reply Declaration does not offer perspective or sufficient explanation as to how a POSITA would have understood these exhibits to support his testimony and conclusions. In particular, Petitioner does not show sufficiently that the imaging systems in *any* of these exhibits achieve "light weight electronic zoom" using "two fixed focal length lenses and 'two (or more) image sensors, having different fixed FOVs'" "with a large lossless zooming range," as Dr. Sasián testifies that Golan teaches. Ex. 1013 ¶ 24 (citing Ex. 1005 ¶ 9). Below, we explain why Dr. Sasián's testimony—which mostly touches on Golan '697 and MicroCam-D—is insufficient to support a finding that any alleged multiple image sensors in Golan '697 or alleged digital zoom capability in NextVision's MicroCam-D described in Exhibits 1026 and 1034 correspond to the specific device and method taught by Golan.

During his deposition, with respect to the disclosure of "a high resolution image sensor" and "a multi-megapixel CMOS" in Golan '697 (Ex. 1022), Dr. Sasián testified that the "optical zoom" in Golan '697 "could refer to either a single lens or two lenses" and cited its claim 27 as support for the proposition that Golan '697 discloses "one or more image sensor

arrays." Ex. 2015, 97:4–8, 98:18–99:10. However, Dr. Sasián stopped short of concluding that Golan '697 teaches "two fixed focal length lenses" and "two (or more) image sensors, having different FOVs" as he does with Golan (Ex. 1013 ¶ 24):

> MR. RUBIN: So would you agree that the Golan '697 patent, Exhibit 1022, never says to use sensors having different angles of view in order to provide a zoom?
>
> MS. SHI: Objection. Out of the scope of the declaration.
>
> DR. SASIÁN: Well, I cannot -- At this moment, I cannot find a mention of different fields of view.

Ex. 2015, 99:14–22. Accordingly, Dr. Sasián's testimony demonstrates that he has not affirmatively testified that Golan '697 teaches sensors having different FOVs, which the accompanying objection of Petitioner's counsel further supports. *Id.* Independent from this deposition testimony, a review of Dr. Sasián's Second Declaration confirms that Dr. Sasián did not testify on whether Golan '697 has different fields of view, and further, whether any exhibit has "light weight electronic zoom" using "two fixed focal length lenses and 'two (or more) image sensors, having different fixed FOVs'" "with a large lossless zooming range," as Dr. Sasián testifies that Golan teaches. *See generally* Ex. 1013; Ex. 1013 ¶ 24 (citing Ex. 1005 ¶ 9).

With respect to the exhibits describing NextVision's MicroCam-D product, Dr. Sasián testified that MicroCam-D "may include more than one camera as the specifications teach camera in plural, cameras." *Id.* at 93:2–5. Dr. Sasián further testified that he did not know whether MicroCam-D utilized a mechanical zoom, and consequently stopped short of determining that MicroCam-D includes "two fixed focal length lenses" and "two (or more) image sensors, having different FOVs" as he did with Golan. *Id.* at

95:2–11; *compare id. with*, Ex. 1013 ¶ 24. When asked about the specific relevance of MicroCam-D to Golan, Dr. Sasián testified as follows:

> MR. RUBIN: What does the MicroCam-D have to do with the Golan patent that you rely on as prior art in this IPR?
>
> DR. SASIÁN: Well, the point I'm bringing up is that there are applications where Golan's disclosure may be relevant, may be applicable. That is the point.

Ex. 2015, 91:6–11.

During his deposition, Dr. Sasián did not rule out using mechanically moving parts to achieve optical zoom in MicroCam-D, which is a subject of multiple exhibits cited by Petitioner. *Id.* at 94:15–95:10. We consider this inquiry relevant to whether Dr. Sasián testifies that any of the exhibits have "light weight electronic zoom" using "two fixed focal length lenses and 'two (or more) image sensors, having different fixed FOVs'" because mechanically moving parts are something Golan avoids with its two fixed focal length lenses having different fields of view. Ex. 1013 ¶ 24 (citing Ex. 1005 ¶ 9); 1005 ¶¶ 7–9. As Dr. Moore explains,

> Traditionally, zoom capability was provided using mechanical optical zooming, moving lens elements relative to each other to change the focal length, and thus the magnification of the lens. Mechanical optical zoom lenses are generally more expensive and larger than fixed focal length lenses. Another approach to zoom is digital zooming, where a digital processor provides a magnification effect by cropping the image from a fixed focal length lens and interpolating between the pixels to create "a magnified but lower-resolution image."
>
> An alternative to both mechanical and traditional digital zoom is described in the '408 patent. In the '408 patent, an improved digital zoom is provided using a "dual-aperture" configuration.

Ex. 2003 ¶¶ 28, 29 (citing Ex. 1001, 1:45–49; 1:54, 3:30–32). Even with respect to the exhibits disclosing digital zoom cited by Petitioner after our Institution Decision, the record does not sufficiently support a finding that there is any disclosure of two image sensors that have different fields of view with fixed focal length lenses. *See, e.g.*, Ex. 2015, 99:14–22. Petitioner also does not make any such representations in its Reply. *See generally* Pet. Reply.

For the reasons discussed above, and particularly with respect to the digital zoom capability of the MicroCam-D camera described in Exhibits 1026 and 1034, the record does not contain sufficient evidence to support a finding that this capability corresponds to the specific method taught by Golan. Nor does the record sufficiently establish that the digital zoom method taught by Golan would have been understood by a POSITA to be the only method—or even one of a few methods—conceivably applicable to MicroCam-D or any other imaging system described in the exhibits cited by Petitioner, to provide the asserted functionality. Petitioner does not explain adequately why we should interpret Golan based on extrinsic evidence that does not "link" the teachings of Golan with any NextVision product or invention. As discussed above, we find Petitioner's contentions and Dr. Sasián's testimony conclusory.

With regard to Petitioner's *second* responsive contention, Petitioner characterizes Patent Owner's argument as limiting the teachings of Golan to the disclosed 5 megapixel image sensor array. Pet. Reply 10–11. We do not agree with Petitioner's characterization of Patent Owner's argument. We understand Patent Owner's reference to the 5 megapixel image sensor array disclosed in Golan as providing the only context in the record for the scale

of device or device components to which Golan's teachings are applied. PO Resp. 8–9; Ex. 1005 ¶ 4. The disclosure of the 5 megapixel image sensor array in Golan supports the finding that Golan is at least applicable to miniature digital cameras and image sensors such as those used in mobile devices. Ex. 1005 ¶ 4. As discussed above, there is no disclosure or evidence that discloses that Golan's teachings are applicable to larger-scale imaging systems, nor is there evidence of record that sufficiently supports a finding that a POSITA would have understood Golan's teachings to be applicable to larger-scale imaging systems, such as those of the size able to accommodate a lens assembly of size disclosed in Kawamura.

With regard to Petitioner's *third* responsive contention that a "POSITA would have understood that, in Golan, the terms 'heavy,' 'expensive,' and 'light weight' are relative," the record does not support a finding that a POSITA would have understood these terms to be relative to a lens assembly of the size taught by Kawamura or of the size of the Fujinon lens. the 5 megapixel image sensor array is the only disclosure in Golan which might indicate to a POSITA what scale of lens assembly Golan's teachings would be applicable to. *Id.* Instead, we determine that a POSITA would have understood these terms to be relative to what is disclosed in Golan, which is a miniature digital camera, and correspondingly-sized image sensors (e.g., 1/4" or 1/3" miniature digital sensors). *See* Ex. 2003 54 (Dr. Moore testifying that a "POSITA . . . in 2013, would have understood that a 5 megapixel sensor was likely to be a 1/3-inch or 1/3-inch sensor . . . .)

With regard to Petitioner's *fourth* responsive contention that Patent Owner improperly discounts Kawamura's teachings as no longer relevant as of Golan's priority date because Patent Owner is relying on the level of skill

in the art as of Kawamura's priority date of 1981, we do not view Patent Owner's arguments in the same way. Petitioner is correct in that the relevant level of skill in the art is *not* the timeframe associated with Kawamura—what constitutes "lightweight" or "compact" must be evaluated through the eyes of a POSITA as of the priority date of the '408 patent. We understand Petitioner to take the position that Kawamura's lens assembly is lightweight compared to some other lens assemblies—like the nearly ten pound Fujinon A36X14.5 lens. As discussed above, even assuming, *arguendo*, that "lightweight" is a relative term, Petitioner does not present sufficient evidence that a POSITA at the time of the priority date of the '408 patent (which could be as early as June 13, 2013 (*see* Ex. 1001, code (60)) would have thought of Kawamura's 7-inch lens assembly as "lightweight" or "compact"—particularly in the absence of any size or weight-related information for comparison in Golan and Golan's disclosure of only a "5 megapixel image sensor array" (*see* Ex. 1005 ¶ 4).

(2) Petitioner's Second Alternative Theory with Scaling

We are not persuaded that Petitioner's evidence sufficiently supports its rationale for combining Golan and Kawamura and a finding that one of ordinary skill in the art at the time of the earliest priority date *of the '408 patent* would have understood Kawamura's lens assembly to be compact in length or that Kawamura's lens assembly would have been understood to address the needs identified in Golan and Golan's "goal to provide an imaging device with '*light weight*' electronic zoom," as Petitioner contends (*supra* §§ III.D.3.e.1), particularly if it would have been necessary to scale Kawamura's lens assembly in order to modify Golan's teachings in

Petitioner's proposed combination. Pet. 20–23 (quoting Ex. 1005 ¶¶ 7–8; Ex. 1007, 1) (citing Ex. 1003 ¶¶ 60–64) (emphasis added). We are further not persuaded that a "POSITA would have scaled the Kawamura lens prescriptions to fit into a digital camera of Golan while *maintaining the compactness* and an excellent image-formation performance." Ex. 1003 ¶ 64 (citing Ex. 1006, 57; Ex. 1009, 254–355) (emphasis added).

We credit the testimony of Dr. Moore that a person of ordinary skill in the art would not have been motivated to scale Kawamura for use in Golan. *See*, *e.g.*, PO Resp. 33–34 (citing Ex. 2003 ¶ 76). Dr. Moore's testimony is supported by the 28-year difference between the Golan and Kawamura inventions and the resulting improvement in performance over decades-earlier, high-quality lenses. *Id.* Dr. Moore also explains that the "Kawamura lens would need to be scaled down by a factor of around 14x to 20x in order provide the same field of view" as Golan. Ex. 2003 ¶ 77 (citing Ex. 2005, 47:24–48:3 (Dr. Moore testifying that Dr. Sasián agrees, in his deposition testimony, with a scaling factor of at least 10).

We also credit Dr. Moore's testimony that "[a] POSITA would not have been motivated to go beyond [the] rich literature of miniature lens designs and try scaling old lenses, designed for different purposes, with little reason to expect the result would be manufacturable." Ex. 2003 ¶ 87. Moreover, Patent Owner has impeached Dr. Sasián's testimony by pointing to positions he has accepted in the past that contradict his testimony in the present proceeding. For example, Dr. Sasián's testimony that the combination of Golan and Kawamura would have been understood to be scalable is contradicted by his article that states that a POSITA would have been dissuaded from scaling a conventional camera lens or traditional

objective lens due to "fabrication constraints, materials['] properties, manufacturing process[es], light diffraction and geometrical aberrations." Ex. 2008, 1. Neither Petitioner nor Dr. Sasián sufficiently explains the contradiction; *see also* Ex. 2013, 79, 83 (Dr. Sasián's student's Ph.D. dissertation discussing issues associated with scaling down a conventional lens and required spatial tolerances). Bareau, an article cited in one of Dr. Sasián's textbooks (Ex. 2006, 195), also discusses manufacturing and fabrication constraints with regard to scaling "a traditional larger-scale imaging lens." Ex. 2012, 1.

(3) Remainder of Petitioner's Reasons for Combining Golan and Kawamura

The remainder of Petitioner's reasons for combining are also insufficient to support a conclusion of obviousness. For example, Petitioner's contentions that Golan and Kawamura are analogous art, share a common objective, and would have produced operable results that are predictable are insufficient to support a conclusion of obviousness. Pet. 20–22 (arguing that "the references are analogous prior art and are in the same field of endeavor pertaining to imaging systems including a telephoto lens," that "they share a need to provide a compact and light weight imaging system while providing excellent image [quality]," and that the combination "would have been no more than the combination of known elements according to known methods").

Although yielding predictable results can, in some situations, sustain a conclusion of obviousness, Petitioner's contention of predictable results is too generic and not sufficiently explained or supported to sustain a conclusion of obviousness. *See In re Kahn*, 441 F.3d 977, 988 (Fed. Cir.

2006) ("[R]ejections on obviousness grounds cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness.").

During the hearing, Patent Owner's counsel noted that "you don't necessarily have to show that that combination would be best, but you do have to provide a motivation to combine with a particular reference." Tr. 44:5–10. We take this opportunity to clarify that we are not requiring Petitioner to point out why Kawamura teaches a better telephoto lens than that of the universe of other telephoto lens assemblies. Patent Owner contends—and Petitioner disputes—that there was a "sea" of telephoto lens patents as of the relevant timeframe. Whether or not there were a "sea" as Patent Owner contends, there were more than a small number of predictable solutions, which even Petitioner's declarant acknowledges. *See* Ex. 2015, 114:14–18 (Dr. Sasián's testimony acknowledging there were several, well-known "lens designs that were publicly known for telephoto and miniature cameras" during the relevant timeframe). We further note that there is insufficient evidence of record to support a finding that a POSITA would have understood that there were only a few options for telephoto lens designs from which to choose such that Kawamura's lens assembly would have been the "obvious" choice. *Cf. Procter & Gamble Co. v. Teva Pharm. USA, Inc.*, 566 F.3d 989, 996 (Fed. Cir. 2009) ("When a person of ordinary skill is faced with 'a finite number of identified, predictable solutions' to a problem and pursues 'the known options within his or her technical grasp,' the resulting discovery 'is likely the product not of innovation but of ordinary skill.'").

Petitioner argues that the term "conventional" in Kawamura refers to the telephoto ratio and not the "compactness of an overall length." Pet. Reply 18–19 (citing Ex. 1007, 1). Even assuming, *arguendo*, that the term "conventional" as disclosed in Kawamura does not apply to the length of Kawamura's lens assembly and instead applies only to Kawamura's telephoto ratio, that still would not alter our finding that a POSITA would not have considered Kawamura to disclose a "lightweight" or "compact" lens assembly as of the earliest priority date of the '408 patent. We are not persuaded for the same reason discussed above, that in the absence of a comparison between two imaging systems of differing sizes in Golan, the record supports a finding that "lightweight" would have been understood to refer to a larger-scale imaging system capable of accommodating a lens assembly of the size disclosed in Kawamura.

For the foregoing reasons, we are not persuaded that Petitioner's rationale for combining Golan and Kawamura is supported by sufficient rational underpinning. As such, we conclude that Petitioner has not shown by a preponderance of the evidence that independent claim 5 is unpatentable over the combination of Golan and Kawamura.

4. Analysis of Dependent Claim 6

As Petitioner's arguments for dependent claim 6 rely on the same rationale for combining as presented with respect to independent claim 5, we conclude that Petitioner has not established by a preponderance of the evidence that dependent claim 6 is unpatentable under 35 U.S.C. § 103 over the combination of Golan and Kawamura.

E. Petitioner’s and Patent Owner’s Objections to Demonstratives

Petitioner objects to various slides in Patent Owner’s demonstratives for the oral hearing. Paper 29. Patent Owner objects to various slides in Petitioner’s demonstratives for the oral hearing. Paper 30. As we do not rely on the demonstratives to reach the conclusion rendered in this Decision, we do not address either party’s objections. Both Petitioner’s and Patent Owner’s objections to the demonstratives are dismissed as moot.

IV. CONCLUSION

For the foregoing reasons, we conclude that Petitioner has not established by a preponderance of the evidence that claims 5 and 6 of the ’408 patent are unpatentable. In summary:

Claim(s)	**35 U.S.C. §**	**References/Basis**	**Claims Shown Unpatentable**	**Claims Not Shown Unpatentable**
5, 6	103	Golan, Kawamura		5, 6
Overall Outcome				**5, 6**

V. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that claims 5 and 6 of the ’408 patent have not been shown to be unpatentable;

FURTHER ORDERED that Petitioner’s objections to the demonstratives are dismissed as moot;

FURTHER ORDERED that Patent Owner’s objections to the demonstratives are dismissed as moot; and

FURTHER ORDERED that, because this is a Final Written Decision, parties to the proceeding seeking judicial review of the decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

For PETITIONER:

David W. O'Brien
Andrew S. Ehmke
Hong Shi
HAYNES AND BOONE, LLP
david.obrien.ipr@haynesboone.com
andy.ehmke.ipr@haynesboone.com
hong.shi.ipr@haynesboone.com

For PATENT OWNER:

Neil A. Rubin
C. Jay Chung
RUSS AUGUST & KABAT
nrubin@raklaw.com
jchung@raklaw.com

Trials@uspto.gov
Tel: 571-272-7822

Paper 41
Entered: July 27, 2022

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

APPLE INC.,
Petitioner,

v.

COREPHOTONICS, LTD.,
Patent Owner.

IPR2020-00489
U.S. Patent 10,015,408 B2

Before GREGG I. ANDERSON, MONICA S. ULLAGADDI, and JOHN R. KENNY, *Administrative Patent Judges.*

ULLAGADDI, *Administrative Patent Judge*.

DECISION
Denying Petitioner's Request on Rehearing
of the Final Written Decision
37 C.F.R. § 42.71
Denying Petitioner's Request to Admit and Consider New Evidence
Denying Patent Owner's Request to Admit and Consider New Evidence
37 C.F.R. § 42.5

I. INTRODUCTION

Apple Inc. ("Petitioner") filed a Petition to institute *inter partes* review of claims 5 and 6 of U.S. Patent No. 10,015,408 B2 (Ex. 1001, "the '408 patent") on February 5, 2020. Paper 2 ("Petition" or "Pet."). Corephotonics, Ltd. ("Patent Owner") filed a Preliminary Response. Paper 7. We instituted an *inter partes* review of each of the challenged claims on the ground set forth in the Petition. Paper 8. Subsequent to institution, Patent Owner filed a Patent Owner Response (Paper 13, "PO Resp."), Petitioner filed a Petitioner Reply (Paper 18), and Patent Owner thereafter filed a Sur-Reply (Paper 20).

An oral hearing was held on May 26, 2021 and a transcript of the hearing has been entered into the record. Paper 31. On July 26, 2021, we entered a Final Written Decision (Paper 32, "Decision" or "FWD") determining that Petitioner did not demonstrate by a preponderance of the evidence that any of the challenged claims were unpatentable. Petitioner requests rehearing (Paper 33, "Req. Reh'g") of our Decision.

In its Rehearing Request, Petitioner urges us to reconsider our Decision, and then also urges us to admit and consider new documents that became available after we entered our Decision. Specifically, Petitioner urges us to admit a brief ("Korean Brief") prepared and submitted by Patent Owner in connection with a proceeding before the Patent Court of Korea ("Korean Court").[1] Patent Owner filed a brief opposing the admission of the Korean Brief. Paper 34 ("PO Brief"). Patent Owner also urges us to admit and consider new documents. Specifically, Patent Owner filed a brief urging us to admit a certified translation of another brief,

[1] Petitioner attaches a certified translation of the Korean Brief to its Rehearing Request.

filed by a third party, LG Innotek Co., Ltd. ("LG Brief") in a proceeding before the 3rd Division of the Korean Court. Paper 35 ("PO LG Brief"). Petitioner opposed admission of the LG Brief. Paper 36 ("Opp. LG Brief"). For the reasons set forth below, Petitioner's Rehearing Request is denied. We further do not admit either the Korean Brief or the LG Brief.

II. LEGAL STANDARDS

A party requesting rehearing bears the burden of showing that a decision should be modified. 37 C.F.R. § 42.71(d). The party must specifically identify all matters it believes the Board misapprehended or overlooked, and the place where each matter was addressed previously in a motion, an opposition, or a reply. *Id.* A request for rehearing, therefore, is not an opportunity merely to disagree with the Board's assessment of the arguments or weighing of the evidence, or to present new arguments or evidence. *See, e.g.*, *Presidio Components, Inc. v. AVX Corporation,* IPR2015-01332, Paper 21, 4 (PTAB Feb. 21, 2016) ("Patent Owner's arguments in this regard amount to a mere disagreement with our analysis or conclusion. But mere disagreement with our analysis or conclusion is not a sufficient basis for rehearing. It is not an abuse of discretion to provide analysis or conclusion with which Patent Owner disagrees.").

III. THE PARTIES' ARGUMENTS

In the Final Written Decision, we determined that Petitioner had not met its burden of showing, by a preponderance of the evidence, that claims 5 and 6 of the '408 patent are unpatentable over U.S. Patent Application Publication No. 2012/0026366 A1 (Ex. 1005, "Golan") and Japanese Patent Application Publication No. S58-62609 (Ex. 1007, "Kawamura"). FWD 2; *see* Pet. 13–20.

Petitioner now requests that we reconsider the conclusion rendered in our Decision and instead conclude that claims 5 and 6 are unpatentable over the combination of Golan and Kawamura. Req. Reh'g 3.

A. Arguments Regarding the Final Written Decision

In Section II.A of its Request for Rehearing, Petitioner argues that, in determining a person of ordinary skill in the art ("POSITA") would not have been motivated to combine Golan and Kawamura, we relied on Patent Owner's "unsupported representations that [a] '***rich literature***' of miniature telephoto lens designs existed in 2013" and arguments that a POSITA would have looked to this "rich literature" instead of looking to Kawamura. Req. Reh'g 5 (quoting FWD 36 ("A POSITA would not have been motivated to go beyond [the] rich literature of miniature lens designs and try scaling old lenses." (quoting Ex. 2003 ¶ 87))) (citing PO Resp. 39; Paper 31, 29:21–24; Sur-Reply 14). Petitioner contends that Patent Owner directly contradicted its representation about the "'rich literature' of miniature telephoto lens designs" in a proceeding before the Korean Court and that, accordingly, our determination that Petitioner's challenge lacked a sufficient motivation to combine Golan and Kawamura is unsupported. *Id.* (emphasis omitted) (citing Ex. 1036, 2, 7).[2] *Infra* §§ IV.A–B.

In Section II.B of the Rehearing Request, Petitioner argues that neither Golan nor Kawamura are limited to their examples and that the Board misconstrued the scope of these references by limiting the disclosed devices to the specific dimensions set forth in the disclosed examples. *Id.* at 7–9 ("The Decision

---

[2] When referring to the Korean Brief, Petitioner cites to Exhibit 1036. A certified translation of the Korean Brief was filed as an attachment to Petitioner's Request for Rehearing, not as an exhibit.

effectively treated Golan's teachings as excluding scope that does not require a miniature telephoto lens, based solely on an exemplary image sensor in Golan's background. This is clear error."). Petitioner contends that our Decision "explained that 'disclosure of the 5 megapixel image sensor array in Golan supports the finding that Golan is at least applicable to miniature digital cameras and image sensors such as those used in mobile devices', but provided no explanation of why and how such 'at least applicable' finding operated as a limitation on a POSITA's understanding of Golan's scope, by excluding scope beyond the 'at least applicable' finding." Req. Reh'g 8 (citing FWD 34) (emphasis omitted). *Infra* §§ IV.C, IV.G.

Petitioner additionally argues that the Board improperly required that the supporting reference, U.S. Patent No. 8,896,697 B2 to Golan et al. (Ex. 1022, "Golan '697") "mention Golan or the invention described" to inform a POSITA's understanding of Golan. *See id.* at 11. Petitioner further argues that the Board made unsupported factual findings by not finding there was sufficient support for image sensors of Golan '697 to correspond to the device and method of Golan. *Id.* at 12 ("The Board's statement that '[t]here is no … evidence that Golan's teachings are applicable to larger-scale imaging systems' (FWD, at 34) is thus erroneous, because it ignores the disclosure in Golan '697 (incorporating provisional application No. 61/167,226, 'the '226 Provisional') of precisely such applications of the teachings of Golan to a larger-scale imaging system."). Petitioner further argues that our Decision "overlooked that Golan (APPL-1005) and Golan 697 (APPL-1022) are related patents, both claiming priority to the same provisional . . . and incorporating that same provisional by reference" and "[a] POSITA would have understood—from the face, common priority and incorporated content—correspondence between a related patent and patent publication from the same

provisional.” *Id.* at 12 (citing Ex. 1005, code (60), ¶ 1; Ex. 1022, code (60), 1:7–10); *infra* § IV.D.

In Section II.C, Petitioner argues that our reliance on Dr. Moore’s testimony was conclusory and ignored modifications well known to a POSITA. Req. Reh’g 16. Petitioner further contends that we erred in concluding that Petitioner’s contention of predictable results was generic without analyzing Petitioner’s arguments. *Id.* (“The Board ignored well-known modifications other than scaling, and ignored Dr. Sasián’s detailed testimony (including lens design software analysis) regarding how a POSITA would have modified Kawamura, *not simply/only scaled* it, to smaller sizes”) (citing Pet. Reply, 22–23; Ex. 1013 ¶¶ 28–33, Appendix B-ZEMAX analysis, ¶¶ 40–49); *infra* §§ IV.I–J.

Finally, Petitioner argues the Board erred by requiring bodily incorporation of Kawamura’s exemplary reference into Golan’s system and ignored modifications that were within a POSITA’s skill. Req. Reh’g 16. Petitioner also argues that “the Decision incorrectly required conclusory proof of ‘a finite number of identified, predictable solutions,’ which is not necessary to show obviousness.” *Id.* at 17 (citing FWD, 38 (“a POSITA would have understood that there were only a few options for telephoto lens design”)). *Infra* §§ IV.H–K.

B. Arguments Regarding the Korean Brief

Petitioner argues that “good cause exists because PO’s admission to the Korean tribunal directly contradicts the representations PO made to this one, and this tribunal was thereby misled into finding in PO’s favor based on those misrepresentations.” Req. Reh’g 1. According to Petitioner, “PO and its expert failed to identify any miniature telephoto lens design out of its alleged ‘rich literature,’ so the Board relied solely on PO’s misrepresentation” but that “days after the FWD, Corephotonics admitted to the Korean tribunal that ‘there were

hardly any telephoto lens assemblies applied to portable terminals' in 2013." *Id.* at 1–2 (citing Ex. 1036, 2, 7); *see id.* at 2 (citing *Ultratec, Inc. v. CaptionCall, LLC*, 872 F.3d 1267, 1271–75 (Fed. Cir. 2017) (abuse of discretion where Board refused to admit and consider conflicting evidence); *Paice LLC v. Toyota Motor Corp.*, 504 F.3d 1293, 1312 (Fed. Cir. 2007) (counsel statements weighed as evidentiary admissions)).

Petitioner further argues that "good cause exists because this new evidence could not have been presented earlier, as PO waited until after the FWD before making its contrary admission in Korea" and that "[t]he Board has found 'good cause' in similar circumstances." *Id.* at 2 (citing *Unified Patents v. MV3 Partners*, IPR2019-00474, Paper 16 at 1–4 (PTAB Aug. 5, 2019) (admitting transcript as new evidence on rehearing where hearing occurred after the Board's decision); *Ultratec*, 872 F.3d at 1272 ("inconsistent testimony did not exist sooner")).

Patent Owner responds that the statements in the Korean Brief cited by Petitioner do not show any contradiction on the part of Patent Owner. PO Brief 1 (explaining that the statements regarding lenses in before the Korean Tribunal dealt with lenses with a Total Track Length (TTL length of < 6.5 mm while scaling Kawamura to be compatible with Golan would lead to a lens with a TTL length of 13.49 mm). According to Patent Owner, "[e]ven assuming that ***no*** telephoto lenses for 'portable terminals' requiring TTL < 6.5 mm had existed in 2013, that would not contradict anything said by Corephotonics or relied on by the Board in the FWD concerning the availability of telephoto lens designs that could have been used instead of a scaled Kawamura lens." *Id.*

Patent Owner further argues that the statements in the Korean Brief were made only as statements about the undeveloped record in the Korean case, and

reflect the substantive difference between American and Korean patent law, namely, the requirement of an inventive step in Korean patent law. *Id.*

Patent Owner also argues that Petitioner's factual position based on the Korean Brief is contrary to what Petitioner itself has previously represented to the Board in other IPR proceedings. *Id.* at 1–2. According to Patent Owner, it is too late after the issuance of the Final Written Decision for Petitioner to change to a long-held factual position. *Id.* at 2.

We discuss the parties' arguments regarding the Korean Brief below in Section IV.A.

C. Arguments Regarding the LG Brief

Patent Owner argues that "[g]ood cause exists to admit the []certified translation of LG Innotek Co., Ltd.'s (LG) August 12 brief to the Patent Court of Korea" because "LG supplies a majority of the camera modules used by Apple, . . . account[ing] for a majority of LG Innotek's revenue" and the LG Brief "clearly shows that Apple's camera module supplier disagrees with the factual premise that Apple now asks the Board to accept: 'that there were almost no telephoto lens assemblies for small form factors available in 2013.'" PO LG Brief 1.

Patent Owner further argues that "the brief shows that Corephotonics' statement about 'one precedent document' in its brief was based on an incompletely developed factual record" and that LG "cites four new prior art references that purportedly show telephoto lens assemblies in a mobile phone." *Id.*

Finally, Patent Owner argues that

> the brief illustrates a difference in substantive law between Korea and the U.S. which underlies the Corephotonics statements Apple points to. Although LG's counsel is aware of the U.S. IPR proceedings, e.g. Attachment at 17, neither they nor Corephotonics mentioned in the Korean case the other mobile phone telephoto lens

> art Apple has cited in its IPRs. *See* Ex. 2015 at 112:7–114:18. That is because those other references were unpublished patent applications as of Corephotonics' priority date. While unpublished applications are considered to be known to the POSITA for purposes of obviousness in the United States, they are not considered within the prior art for the purposes of "inventive step" in Korea. KIPO Patent Examination Guidelines, January 2021 at 303–04, 341–43 (https://www.kipo.go.kr/upload/en/download/Patent_Examination_Guidelines_2021.pdf).

Id.

Petitioner responds that the LG Brief is a "*non-party* statement" that "is not relevant to the question presented by PO's Korean Brief: namely, whether, in fairness and the interests-of-justice, *PO* should be allowed to take directly contrary positions before different judicial tribunals in order to secure patentability of patents from the same field and timeframe." Opp. LG Brief 1.

We discuss the parties' arguments regarding the LG Brief below in Section IV.L.

IV. ANALYSIS

Turning to Petitioner's arguments, we begin by noting that Petitioner has not pointed us to precedent for admitting evidence after trial has concluded and after a Final Written Decision has issued. *See* Req. Reh'g 4–7. In *Huawei Device Co. v. Optis Cellular Tech.*, IPR2018-00816, Paper 19 at 4 (PTAB Jan. 8, 2019) (precedential), the Board determined that the standard for admitting new evidence with a rehearing request requires a showing of good cause. Separately, 37 C.F.R. § 42.123 requires that any supplemental evidence must be filed within *one month* of the date the trial is instituted and late submissions of evidence beyond this date must be in the interest of justice. *Id.* In the present proceeding, for the reasons discussed below, we did not solely rely on Dr. Moore's testimony regarding the

"rich literature of miniature telephoto lenses" and even if we disregard that testimony completely, the outcome of our Decision would not change as we explain in detail in Section IV.A below.

A. The Korean Brief Is Not Admitted

As to Petitioner's first argument in Section II.A, Petitioner is correct in noting that we credited Dr. Moore's testimony that "[a] POSITA would not have been motivated to go beyond [the] rich literature of miniature lens designs and try scaling old lenses, designed for different purposes, with little reason to expect the result would be manufacturable." Req. Reh'g 5; FWD 36 (quoting Ex. 2003 ¶ 87). This portion of Dr. Moore's testimony is not directly contradicted by the Korean Brief because, in the Korean Brief, Patent Owner states that "there were hardly any telephoto lens assemblies *applied to portable terminals* at the time the application of the invention of the subject patent was filed" noting that "only one . . . Reference 1 (Exhibit No. Eul-4) discloses the small telephoto lens assembly *for portable terminals* before the priority date of the invention of the subject patent." *Id*. (Korean Brief Attachment 2) (emphasis added); *see also id.* at 7 ("Since the technical concept of the telephoto lens assembly for a portable terminal was different from the general telephoto camera in many ways, <u>at the time of filing for the invention for the subject patent</u>, a person of ordinary skill in the art did not think that the telephoto lens assembly could be installed in the portable terminal). That is, Dr. Moore refers to a breadth of miniature lens designs, whereas the Korean Brief more particularly refers to a dearth of telephoto lens assemblies *applied* to portable terminals—the record does not indicate that the portable terminals mentioned in the Korean Brief are necessarily miniature. Thus, the admission of the Korean Brief is moot because its admission would not affect our analysis. Therefore, good cause does not exist, nor would it be in the interest of

justice, to admit the Korean Brief as it would expend judicial resources and expand the scope of a concluded trial without sufficient cause.

B. Petitioner's Challenge Was Deficient Even Absent Dr. Moore's Allegedly Contradictory Testimony

Even if we were to exclude this portion of testimony (i.e., had this portion of Dr. Moore's testimony been stricken from the record), our conclusion of obviousness would not change. Patent Owner's allegedly contradictory statements do not change the outcome in this case because Petitioner, not Patent Owner, bears the burden of showing that the claims were obvious under their proposed combination. *Dynamic Drinkware, LLC v. Nat'l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015). To prevail, Petitioner must prove unpatentability by a preponderance of the evidence. *See* 35 U.S.C. § 316(e) (2018); 37 C.F.R. § 42.1(d) (2019). For the reasons below in our discussion of Petitioner's arguments set forth in Sections II.B and II.C of its Rehearing Request, Petitioner did not meet this burden—Petitioner's challenge was deficient on its own, irrespective of whether we gave weight to this portion of Dr. Moore's testimony. Stated differently, even if we discredited Dr. Moore's testimony with regard to the "rich literature of miniature lens designs," for example, because of the statements in the Korean Brief, Petitioner failed to present sufficient evidence that supports a determination that a POSITA would have contemplated the proposed modifications, and ultimately, recognized the obviousness of the proposed combination of Golan and Kawamura.

C. Golan Is Not Limited to the Dimensions of Its Examples

Petitioner's arguments in Section II.B. of the Rehearing Request mischaracterize our Decision as limiting Golan and Kawamura to their examples. *See* Req. Reh'g 7–9. In our Decision, we noted that Golan expressly discloses a 5

megapixel image sensor array, but that "there is insufficient evidence of record to support the proposition that Golan's teachings are applicable to imaging systems that are of a scale larger than that of the miniature cameras and image sensors used in mobile devices." FWD 26. We based this determination, in relevant part, on Dr. Sasián's Reply Declaration (*see, e.g.*, Ex. 1013 ¶¶ 15–21, 28), in which he testified that Golan's teachings are applicable to imaging systems that are of a scale larger than that of the miniature cameras and image sensors used in the systems of Exhibits 1022, 1024, 1026, 1029–1032, 1034, and 1035, which were cited to support this testimony. We found this testimony to be unpersuasive because Exhibits 1022, 1024, 1026, 1029–1032, 1034, and 1035 do not address devices like those taught by Golan. Exhibits 1022, 1024, 1026, 1029–1032, 1034, and 1035 exemplify different sizes of imaging systems, but do not indicate that an image sensor array and device *of the type disclosed in Golan* —a dual lens, fixed focal length digital imaging system with two different fields of view—would have been understood to have the different (larger) dimensions and pixel resolutions of the magnitude of Kawamura.[3] *See* Ex. 1013 ¶ 18; PO Resp. 6–8 (citing-in-part Ex. 2015, 99:14–22); FWD 30 (citing Ex. 1013 ¶ 24 (citing Ex. 1005 ¶ 9)). The devices disclosed in Exhibits 1022, 1024, 1026, 1029–1032, 1034, and 1035 are smaller than that which is sufficient to accommodate a lens assembly of the size disclosed in Kawamura. And Dr. Sasián did not persuasively explain why the

[3] Exhibit 1029 discloses Kodak's EasyShare V610 dual-lens digital camera manual as having a 1/2.5" sensor and a 5.3-megapixel image. *Infra* § IV.E. Dr. Sasián does not indicate that the two lenses have a fixed focal length or different fields of view, nor does he persuasively explain why the teachings of Exhibit 1029 would applicable to a system with two lenses having fixed focal lengths and/or different fields of view. Ex. 1013 ¶ 21.

teachings of Exhibits 1022, 1024, 1026, 1029–1032, 1034, and 1035 would be applicable to Golan. Ex. 1013 ¶¶ 15–21, 28. We did not require, as claimed by Petitioner, that a supporting or background reference *must* mention Golan or its invention. *See* FWD 30–33; *see also* Req. Reh'g 11 (quoting FWD 30–33 ("[t]he Board then compounded its exclusion error, reasoning that a supporting reference must 'mention Golan or the invention described therein,' to inform a POSITA's understanding")). Instead, we determined that "Petitioner does not point to any portion of these exhibits that mentions Golan or the invention described therein," "[n]or does Petitioner point to evidence that sufficiently addresses the applicability of Golan's specific teachings to any particular product or imaging system described in the cited exhibits," nor does Dr. Sasián's Reply Declaration "offer perspective or sufficient explanation as to how a POSITA would have understood these exhibits to support his testimony and conclusions," nor does Petitioner "show sufficiently that the imaging systems in *any* of these exhibits achieve 'light weight electronic zoom' using 'two fixed focal length lenses and "two (or more) image sensors, having different fixed FOVs"' 'with a large lossless zooming range,' as Dr. Sasián testifies that Golan teaches." FWD 30 (citing Ex. 1013 ¶ 24 (citing Ex. 1005 ¶ 9)).

With regard to the cases we cited in our Decision as a "useful comparison" (i.e., using "*Cf.*"), *Abbott Labs. v. Dey, L.P.*, 287 F.3d 1097, 1104 (Fed. Cir. 2002) and *Astrazeneca AB v. Mut. Pharm. Co.*, 384 F.3d 1333, 1340 (Fed. Cir. 2004), Petitioner contends that neither case limits "the use of supplemental prior art references for showing a POSITA's 'background knowledge' and understanding of ***reference disclosure***" and that "[n]either case alters the rule that a ***prior art reference*** must be evaluated 'not only for what it expressly teaches, but also for what it fairly suggests.'" Req. Reh'g 11 (citing *Bradium Technologies LLC v.*

Iancu, 923 F. 3d 1032, 1049 (Fed. Cir. 2019)). We agree with Petitioner that a prior art reference must be evaluated in context and for what it fairly suggests. Petitioner, however, has not shown that the prior art it cites suggest the claimed invention.

D. Golan ’697 Is Not Dispositive as to how To Interpret Golan

As set forth above, it is Petitioner’s burden in an IPR proceeding to show that the contested claims are unpatentable. Here, Petitioner did not provide sufficient explanation, nor point to relevant case law, to explain why would should consider the disclosure of Golan ’697 to be part of Golan’s disclosure. Golan does not incorporate Golan ’697 by reference, and Petitioner did not point to any case law supporting a presumption that Golan and Golan ’697 refer to the same invention because both claim priority to and incorporate by reference the ’226 Provisional. *See* Req. Reh’g 12–15. We further note that Golan and Golan ’697 have different titles, abstracts, and specifications. *Compare* Ex. 1001 *with*, Ex. 1022. Petitioner also does not persuasively explain why Golan ’697 provides relevant background information for Golan.

Petitioner’s citations to *Unwired Planet, LLC v. Apple Inc.*, 829 F.3d 1353, 1359 (Fed. Cir. 2016) and *Home Diagnostics, Inc. v. LifeScan, Inc.*, 381 F.3d 1352, 1357 (Fed. Cir. 2004) are inapposite. *Unwired Planet* concerns how we interpret patent claims in light of the specification, and warns against limiting claims beyond their plain meaning to include a limitation disclosed in all of the embodiments or the only embodiment. *Unwired Planet*, 829 F.3d at 1359. Similarly, in *Home Diagnostics*, the Federal Circuit held that “the patent’s preferred embodiment is just that—one way of using the invention” and “[t]hat disclosure alone does not clearly and unambiguously disavow other ways of computing the endpoint *within the scope of the claim language*.” *Home*

Diagnostics, 381 F.3d at 1357 (emphasis added). As we have repeatedly stated, we are not limiting Golan to a device having the expressly-disclosed resolution (i.e., 5 megapixels) and correspondingly-dimensioned image sensor array and imaging device. We clarify that we determine, instead, that a POSITA would not have understood Golan to teach or suggest image sensor arrays or imaging devices of a size compatible with that of the telephoto lens assemblies taught or suggested by Kawamura.

In any event, Golan '697 conveys little, if anything, about size and instead, was cited in Dr. Sasián's testimony as disclosing "an imaging system, operatively mounted on an air-born vehicle." Ex. 1013 ¶ 17. It does not even discuss scaling an image sensor array, imaging device, or lens assembly—at best, it discloses that "[a]n image sensor is generally subject to motion and vibrations which might distort a detected image of a scene" in which "[t]he motion can be linear, where the image sensor undergoes a linear displacement or scaling, and the motion can be angular, where the image sensor rotates about one or more axes." Ex. 1022, 1:23–27.

E. Golan's Disclosure of a 155-megapixel Resolution Relates to a Prior Art Single Optical Zoom Lens, not Its Dual-Lens Electronic Zoom Device

Petitioner notes that our finding that Golan only discloses a size of 5 megapixels "is, in fact, contrary to Golan's disclosure" because Golan describes an example of a 155-megapixel image sensor array that can obtain an optical zoom of x36. Req. Reh'g 13 (citing Pet. Reply 7–11; Ex. 1005, Fig. 1, ¶ 13; Ex. 1022, 1:14–18, 1:67–2:1, 5:55–57; '226 Provisional (expressly incorporated in Ex. 1005 and 1022), 3:12–13, Fig. 5 (describing Fig. 5 as a "zoom control sub-system for an air-born camera system")). Petitioner's argument does not provide the necessary context of this disclosure in Golan.

Golan discloses that

> *the present invention describes a continuous electronic zoom* for an image acquisition system, having multiple imaging devices each with a different fixed field of view (FOV). Using two (or more) *image sensors, having different fixed FOV*, facilitates a light weight electronic zoom with a large lossless zooming range. For example, a first image sensor has a 60° angle of view and a second image sensor has a 60° angle of view. Therefore, Wide_FOV=Narrow_FOV*6. Hence, switching between the image sensors provide a lossless *electronic* zoom of 6^2=36.

Ex. 1005 ¶ 9 (emphasis added). Golan contrasts this example of its invention having lossless *electronic* zoom of x36, which is achieved two image sensors each having *fixed* fields of view, with "obtain[ing] similar zoom (x36) by *optical means*," noting that, "for an output resolution frame of 400x300, the needed sensor array is" a 155-megapixel image sensor array. *Id.* ¶¶ 10, 13 (emphasis added). Golan explains that "[e]lectronic zoom is accomplished by cropping an image down to a centered area of the image with the same aspect ratio as the original . . . without any adjustment of the camera's optics, and no optical resolution is gained in the process." *Id.* ¶ 3. Golan explains that "[e]lectronic zoom *does not need moving mechanical elements, as does optical zoom*." *Id.* ¶ 7 (emphasis added). As part of its background, Golan recognizes that "[t]ypically, a camera with a large dynamic zoom range requires heavy and expensive lenses, as well as complex design" and as such, "[t]here is a need for and it would be advantageous to have image sensors, having static, light weight electronic zoom and a large lossless zooming range." *Id.* ¶¶ 7, 8. Thus, Golan *contrasts* the size of image sensor array (i.e., 155 megapixels) and lenses needed to achieve an optical zoom that is on the same order of electronic zoom achievable by Golan's invention.

Accordingly, we are not persuaded to alter our Decision based on this argument and the cited portions of Golan. More particularly, we are not persuaded

that Golan teaches or suggests using its invention—an imaging device with image sensors with fixed fields of view "having static, light weight electronic zoom and a large lossless zooming range"—with the contrasted "heavy and expensive lenses" image sensor arrays providing resolutions on the order of 155 megapixels and other correspondingly-sized components. *Accord* PO Resp. 20 (citing Ex. 2007 (Galstain), 4; Ex. 2003 ¶ 53) ("It is only in the largest, most expensive sensors, having pixel counts in excess of 10 megapixels, that pixels are larger.").

Petitioner contends that "[t]he Board's finding that Golan is limited to 'a miniature digital camera' with 'correspondingly-sized image sensors (*e.g.*, 1/4-inch or 1/3-inch miniature digital sensors)' also overlooked undisputed evidence that the exemplary 5MP (***resolution***) sensor may be implemented as a sensor of different ***dimension***, such as a nonminiature 1/2.5-inch sensor" and that "PO never addressed this evidence." Req. Reh'g 14 (citing Pet. Reply 11; Ex. 1029, 62; Ex. 1013 ¶ 21; FWD, 26, 28).

Our Decision states that "there is insufficient evidence of record to support the proposition that Golan's teachings are applicable to imaging systems that are of a scale larger than that of the miniature cameras and image sensors used in mobile devices" and describes "correspondingly-sized image sensors (e.g., 1/4" or 1/3" miniature digital sensors)" as exemplary, *not* limiting as Petitioner contends. FWD 26, 34. We note that Patent Owner's evidence, Table 1.1 comparing camera formats in Galstain, does not depict whether a 1/2.5" sensor would fall under the "miniature camera modules" heading or the "digital still cameras" heading. Ex. 2007, 62. The largest sensor under the "miniature camera modules" heading is 1/3" and the smallest sensor under the "digital still cameras" heading is 1/2.3"—if anything, a 1/2.5" sensor is closer to the size of sensor consistent with a digital still camera instead of the size of sensor consistent with a miniature camera module.

Accord Ex. 1029, 62 (Kodak's EasyShare V610 dual-lens digital camera manual disclosing a 1/2.5" sensor and a 5.3-megapixel image).

F. Petitioner's Challenge Does Not Explain "Relative to"

Irrespective of whether a 5-megapixel resolution as disclosed in Golan can be achieved using a 1/2.5" sensor, the only reason Petitioner provides for looking to Kawamura is that Golan does not disclose a specific lens prescription for its telephoto lens and as such, "a POSITA would have been motivated to apply Kawamura's teachings of tele lens because of the imaging benefits *and compactness of an overall length* with excellent image-formation performance as taught by Kawamura." Pet. 20 (citing Ex. 1003 ¶ 60) (emphasis added). But the Petition does not explain what the "compactness of an overall length" of Kawamura's telephoto lens assembly *is relative to*. The record does not sufficiently show how Kawamura's telephoto lens assembly would be considered compact enough in overall length to be used with, for example, a 1/2.5" sensor, nor does it explain how an approximately 7.9-inch telephoto lens assembly (i.e., with an approximately 200 mm focal length) would have been considered "lightweight" relative to Golan's invention, nor does it explain how the 7.9-inch lens assembly in 1983 would have been considered "lightweight" by a POSITA at the time of the invention of the '408 patent at least thirty years later.

To the extent that "Petitioner . . . take[s] the position that Kawamura's lens assembly is lightweight compared to some other lens assemblies—like the nearly ten pound Fujinon A36X14.5 lens," (*see* FWD 35), this position was not presented with sufficient particularity in the *Petition* at least because the Petition does not cite any teaching or suggestion of the weight or size of the single optically-variable zoom lens set forth in Golan's background. Although Dr. Sasián testifies that what constitutes "heavy" or "lightweight" is relative (Ex. 1013 ¶ 25), the Petition never

addresses what these terms are relative to. As such, we are not persuaded that we "misapprehended 'lightweight,' divorced from Golan's context of achieving 'lightweight' by using fixed focal length lenses in digital zoom rather than a single optically-variable zoom lens, and errantly required 'lightweight' to be lighter than some unspecified value presumptively associated with Golan's exemplary 5MP sensor." Req. Reh'g 14 (citing FWD 35).

G. Kawamura Is Not Limited to Its Examples

Petitioner contends that "Kawamura's 'Scope of Patent Claim' is not limited by focal length/dimension/weight, so the scope of Kawamura disclosure, including at least its scope of patent claim, also would not have been understood to be so limited." Req. Reh'g 10 (citing Pet. 15–17, 22–23; Ex. 1007, 1, Fig. 1; Ex. 1013 ¶¶ 29–33, Table 1). Petitioner contends that, instead, "Kawamura both teaches and fairly suggests a continuum of telephoto lens designs as a function of a desired focal length (F) using conditions (1) to (8) (FIG. 2A), which are ***not*** limited to any particular focal length or size/weight inferred therefrom (*see* FIGS. 2B-2C)." *Id.* This argument does not appear in the cited portions of the record (Pet. 15–17, 22–23 (citing Ex. 1007, 1 (Title, Scope of Patent Claim), Fig. 1; Ex. 1003 ¶¶ 53–59; Ex. 1013 ¶¶ 29–33, Table 1) and Petitioner's Figures 2A–2C do not appear to be have been presented before the Rehearing Request. *See* 37 C.F.R. § 42.71(d) ("The party must specifically identify all matters it believes the Board misapprehended or overlooked, *and the place where each matter was addressed previously in a motion, an opposition, or a reply*." (emphasis added)). While we do *not* limit Kawamura to only the ~200mm focal length of its examples, the record does not support a finding that a POSITA would have understood Kawamura to teach or suggest a telephoto lens assembly with a lens prescription

that has any focal length, size, and weight, such that it would have been considered "lightweight" or compact in overall length relative to Golan's invention or other, background disclosures, or relative a POSITA's understanding of those terms at the time of the invention of the '408 patent.

H. The Decision Did Not Require Petitioner To Show a Finite Number of Options

Aside from asserting that Kawamura's telephoto lens assembly had a "compactness of overall length," Petitioner does not provide any standalone, non-generic reason for looking to Kawamura, i.e., other than the fact that Golan does not disclose a specific lens prescription for its telephoto lens. In our Decision, we noted that "there is insufficient evidence of record to support a finding that a POSITA would have understood that there were only a few options for telephoto lens designs from which to choose such that Kawamura's lens assembly would have been the "obvious" choice." FWD 38 (citing *Procter & Gamble Co. v. Teva Pharm. USA, Inc.*, 566 F.3d 989, 996 (Fed. Cir. 2009)). We did *not* make it a requirement for Petitioner to show a finite number of options for telephoto lenses or miniature telephoto lenses. In the absence of any persuasive reason to look to Kawamura in particular (we explained above why the reason about Kawamura's disclosure of "compactness of overall length" was not persuasive), we *further* noted that did not Petitioner remedy the deficiency by persuasively explaining that there were few or no miniature telephoto lens designs to look to (Petitioner did not make this argument until its Reply) such that combining Kawamura with Golan would have been obvious to POSITA—we did not *require* Petitioner to show this. FWD 38 (citing *Procter & Gamble Co. v. Teva Pharm. USA, Inc.*, 566 F.3d 989, 996 (Fed. Cir. 2009) ("We *further* note that there is insufficient evidence of record to support a finding that a POSITA would have understood that there were only a few options for telephoto lens designs from which to choose such that Kawamura's

lens assembly would have been the 'obvious' choice." (emphasis added)); *see also* Ex. 2015, 114:14–18 (Dr. Sasián's testimony acknowledging there were several, well-known "lens designs that were publicly known for telephoto and miniature cameras" during the relevant timeframe).

Supporting Petitioner's rationale for combining Golan and Kawamura, Dr. Sasián testified that any needed modification would have been within the level of ordinary skill in the art and specifically, that lens scaling was a well-known practice in lens design. Ex. 1003 ¶¶ 63, 64 (quoting Ex. 1006 ("A lens prescription can be scaled to any desired focal length simply by multiplying all of its dimensions by the same constants. All of the linear aberration measures will then be scaled by the same factor.")). Dr. Sasián's testimony is that Kawamura *could* be scaled, but doesn't explain why a POSITA would think Kawamura was small enough or should be scaled to be small enough to be compatible with Golan's invention. *See id.* ¶ 64. *See Belden Inc. v. Berk-Tek LLC*, 805 F.3d 1064, 1073 (Fed. Cir. 2015) ("[O]bviousness concerns whether a skilled artisan not only could have made but would have been motivated to make the combinations or modifications[.]").

I. The Decision Did Not Ignore or Misunderstand Dr. Sasián's Testimony

Petitioner's arguments in Section II.C of the Rehearing Request rehash arguments considered fully and rejected in our Final Written Decision, and fail to show that we misapprehended or misconstrued those arguments in reaching that conclusion. *See* Req. Reh'g 16 (citing Pet. Reply 22–23; Ex. 1013 ¶¶ 28–33, Appendix B-ZEMAX analysis, ¶¶ 40–49) ("The Board ignored well-known modifications other than scaling, and ignored Dr. Sasián's detailed testimony (including lens design software analysis) regarding how a POSITA would have modified Kawamura, *not simply/only scaled* it, to smaller sizes."). In using the

term "scaling" in the Final Written Decision and in this Decision, we use it in the same manner as Petitioner and Dr. Sasián, that is, to encompass scaling and additional, attendant modifications:

> A POSITA would have *scaled* the Kawamura lens prescriptions to fit into a digital camera of Golan while maintaining the compactness and an excellent image-formation performance. As shown with examples in Table 1 below, a POSITA would have understood that *sensors of various formats may be used in the combination of Golan and Kawamura based on the application*, *would have applied the appropriate scaling factor based on the image sensor format* (e.g., scaling factors less than 10 for image sensors of 1/3" or greater), *and would have found that modifications of Kawamura's lens for the combination is practical*. Further, a POSTA would have found it practical, and indeed, would have *modified the field of view of Kawamura's lens for a tele field of view* that's appropriate for a particular application (e.g., conventional digital still cameras, air-born vehicles/drones applications, etc.), including the example Narrow_FOV described in Golan.

Ex. 1013 ¶ 30 (emphasis added). If it was not persuasive to us that a POSITA would scale Kawamura, it is not clear why we would have considered and found Dr. Sasián's testimony that a POSITA "would have found it practical, and indeed, would have modified the field of view of Kawamura's lens for a tele field of view that's appropriate for a particular application (e.g., conventional digital still cameras, air-born vehicles/drones applications, etc.), including the example Narrow_FOV described in Golan" sufficiently persuasive on its own. *Id*.

In the Rehearing Request, Petitioner argues that the Board misunderstood Dr. Sasián's past statements. Petitioner argues that Dr. Sasián claimed lenses cannot be *simply* be scaled, which Petitioner alleges the Board construed as meaning lenses are *unable* to be scaled down. *See* Req. Reh'g 15–16. Petitioner misconstrues our Decision—we were not persuaded that Kawamura's lens

assembly would meet the needs identified in Golan, such as being lightweight. *See* FWD 35–36. Additionally, we noted that Dr. Sasián's testimony is contradicted by his position taken in a published article that a POSITA may be dissuaded from such scaling due to an increase in fabrication and cost of materials, which are relevant considerations for determining if there is sufficient motivation to combine. FWD 36–37 (citing Ex. 2008, 1). Therefore, it is relevant whether Petitioner's expert takes the position that Kawamura's lens *assembly* cannot *simply* be scaled and cheaply—the above considerations and the difficulty of scaling weigh against motivation to combine. *See id*. As discussed in the next section, we also considered Patent Owner's arguments and the portions of Dr. Moore's testimony that are supported by sufficient underlying evidence.

J. Patent Owner's Arguments and Dr. Moore's Testimony Are Not Conclusory and Are Supported by Evidence of Record

Contrary to Petitioner's assertion, the Board's analysis did not adopt the conclusory opinion of Dr. Moore without evidence. We looked to considerations such as: manufacturing and fabrication constraints, material properties, diffraction and geometrical aberrations, which we were persuaded would have dissuaded a POSITA from scaling Kawamura in one of Petitioner's alternative theories. *See* FWD 22, 23, 36–37 (citing-in-part Ex. 2008 (Reshidko), 1; Ex. 2012 (Bareau), 1). We clarify for the record we did not solely consider Reshidko and Bareau for the purposes of impeaching Dr. Sasián's testimony—we found Patent Owner's argument supported by the cited portions of these pieces of underlying evidence. Ex. 2008, 1; Ex. 2012, 1, 3; PO Resp. 35–37.

K. The Decision Did Not Misapply KSR nor Did the Decision Require Bodily Incorporation of Kawamura into Golan

For similar reasons, we likewise disagree with Petitioner's argument that we misapplied the law under *KSR International Co. v. Teleflex, Inc.*, 550 U.S. 398 (2007), and required bodily incorporation of Kawamura's telephoto lens assembly. *See* Req. Reh'g 17. We did not do so. Instead, we determined that Petitioner did not present sufficient evidence that a POSITA would have been motivated to combine Kawamura's lens assembly with Golan, particularly in light of the above considerations relating to scaling, as set forth above. FWD 35 ("Petitioner does not present sufficient evidence that a POSITA . . . would have thought of Kawamura's 7-inch lens assembly as "lightweight" or "compact[.]"). Because Petitioner did not provide sufficient underlying evidence to support their reason, and because there are significant countervailing considerations a POSITA would have balanced, Petitioner did not meet this burden, and was not able to sufficiently show a motivation to combine that is supported by sufficient rational underpinning.

L. The LG Brief Is Not Admissible

Good cause does not exist, nor is it in the interests of justice, to admit the LG brief because even if it were admitted, it would not alter the outcome of our Decision. That is, it would not make any fact relied upon in our Decision more or less likely. This is due to the fact that LG brief includes only statements by a non-party to the present proceeding to a tribunal different from the one that adjudicates this IPR proceeding.

V. CONCLUSION

For the foregoing reasons, we are not persuaded that we misapprehended or overlooked any matter.

VI. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that Petitioner's Request for Rehearing is *denied*;

FURTHER ORDERED that Petitioner's request to admit and consider the Korean Brief is denied; and

FURTHER ORDERED that Patent Owner's request to admit and consider the LG brief is denied.

For PETITIONER:

David W. O'Brien
Andrew S. Ehmke
Hong Shi
HAYES AND BOONE, LLP
David.obrien.ipr@haynesboone.com
Andy.ehmke.ipr@haynesboone.com
Hong.shi.ipr@haynesboone.com

For PATENT OWNER:

Neil Rubin,
C. Jay Chung,
Marc A. Fenster,
James S. Tsuei,
RUSS AUGUST & KABAT
nrubin@raklaw.com
jchung@raklaw.com
mfenster@raklaw.com
jtsuei@raklaw.com

US010015408B2

(12) **United States Patent**
Shabtay et al.

(10) **Patent No.: US 10,015,408 B2**
(45) **Date of Patent: Jul. 3, 2018**

(54) **DUAL APERTURE ZOOM DIGITAL CAMERA**

(71) Applicant: **Corephotonics Ltd.**, Tel-Aviv (IL)

(72) Inventors: **Gal Shabtay**, Tel Aviv (IL); **Ephraim Goldenberg**, Ashdod (IL); **Oded Gigushinski**, Herzlia (IL); **Noy Cohen**, Tel-Aviv (IL)

(73) Assignee: **Corephotonics Ltd.**, Tel Aviv (IL)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **15/424,853**

(22) Filed: **Feb. 5, 2017**

(65) **Prior Publication Data**

US 2017/0150061 A1 May 25, 2017

Related U.S. Application Data

(63) Continuation of application No. 14/880,251, filed on Oct. 11, 2015, which is a continuation of application (Continued)

(51) **Int. Cl.**
H04N 5/232 (2006.01)
H04N 5/225 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H04N 5/23296*** (2013.01); ***G02B 13/0015*** (2013.01); ***G02B 27/0075*** (2013.01); ***H04N 5/2258*** (2013.01); ***H04N 5/23212*** (2013.01)

(58) **Field of Classification Search**
CPC H04N 5/23296; G02B 13/0015
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

9,405,099 B2 * 8/2016 Jo G02B 13/0045
9,576,369 B2 * 2/2017 Venkataraman .. H01L 27/14618
(Continued)

FOREIGN PATENT DOCUMENTS

JP 2013106289 A * 5/2013 .... H04N 5/2258
JP 5741395 7/2015

OTHER PUBLICATIONS

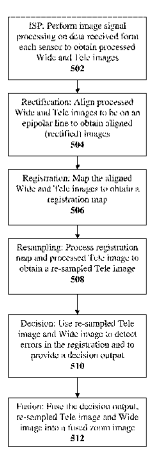
JP 2013106289 A; May 2013; Machine English Translation; Japan Platform Patent Information; pp. 1-18.*
(Continued)

Primary Examiner — Cynthia Segura
(74) *Attorney, Agent, or Firm* — Nathan & Associates Patent Agents Ltd.; Menachem Nathan

(57) **ABSTRACT**

A dual-aperture zoom digital camera operable in both still and video modes. The camera includes Wide and Tele imaging sections with respective lens/sensor combinations and image signal processors and a camera controller operatively coupled to the Wide and Tele imaging sections. The Wide and Tele imaging sections provide respective image data. The controller is configured to combine in still mode at least some of the Wide and Tele image data to provide a fused output image from a particular point of view, and to provide without fusion continuous zoom video mode output images, each output image having a given output resolution, wherein the video mode output images are provided with a smooth transition when switching between a lower zoom factor (ZF) value and a higher ZF value or vice versa, and wherein at the lower ZF the output resolution is determined by the Wide sensor while at the higher ZF value the output resolution is determined by the Tele sensor.

7 Claims, 8 Drawing Sheets



Related U.S. Application Data

No. 14/365,711, filed as application No. PCT/IB2014/062180 on Jun. 12, 2014, now Pat. No. 9,185,291.

(60) Provisional application No. 61/834,486, filed on Jun. 13, 2013.

(51) **Int. Cl.**
G02B 13/00 (2006.01)
G02B 27/00 (2006.01)

(56) **References Cited**

U.S. PATENT DOCUMENTS

9,633,442	B2 *	4/2017	Venkataraman	G06T 7/593
2006/0187312	A1	8/2006	Labaziewicz et al.	
2007/0229697	A1 *	10/2007	Choi	H04N 5/2257 348/345
2008/0030592	A1 *	2/2008	Border	H04N 5/232 348/218.1
2008/0187310	A1	8/2008	Tanaka	
2008/0218613	A1	9/2008	Jenson et al.	
2009/0002839	A1	1/2009	Sato	
2010/0277269	A1	11/2010	Scarff	
2011/0080487	A1	4/2011	Venkataraman et al.	
2011/0129210	A1 *	6/2011	McGucken	F16M 13/02 396/422
2012/0074227	A1 *	3/2012	Ferren	G02B 13/0065 235/462.21
2012/0206458	A1 *	8/2012	El Dokor	G06F 3/0421 345/423
2012/0314296	A1 *	12/2012	Shabtay	G02B 13/18 359/662
2013/0182335	A1 *	7/2013	Tsai	G02B 13/0045 359/714
2013/0215289	A1 *	8/2013	Vitsnudel	H04N 5/232 348/231.99
2013/0335833	A1 *	12/2013	Liao	G02B 13/0045 359/713
2014/0009585	A1 *	1/2014	Campbell	H04N 13/0203 348/47
2015/0009395	A1 *	1/2015	Ono	H04N 5/2254 348/360
2015/0161798	A1 *	6/2015	Venkataraman	G01P 3/38 348/47
2015/0198784	A1 *	7/2015	Bone	G02B 13/004 359/708
2017/0102513	A1 *	4/2017	Ogata	G02B 7/021
2017/0249053	A1 *	8/2017	El Dokor	G06F 3/0421
2017/0276911	A1 *	9/2017	Huang	G02B 13/0045

OTHER PUBLICATIONS

European Supplementary Search report in related EP patent application 14810366.6, dated Apr. 6, 2016, 4 pages.

* cited by examiner

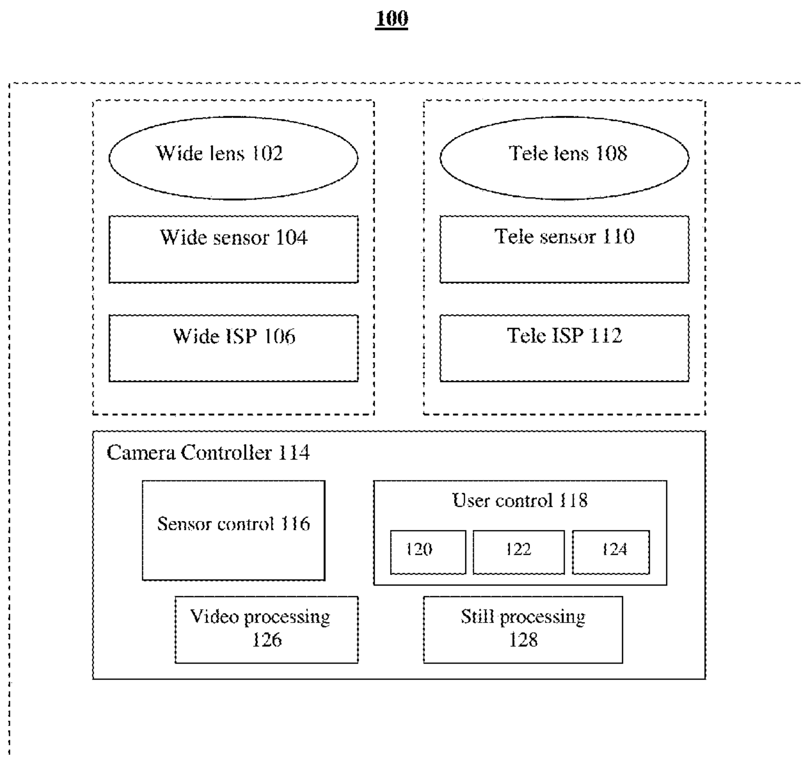

100
Wide lens 102
Tele lens 108
Wide sensor 104
Tele sensor 110
Wide ISP 106
Tele ISP 112
Camera Controller 114
Sensor control 116
User control 118
120
122
124
Video processing 126
Still processing 128

FIG. 1A

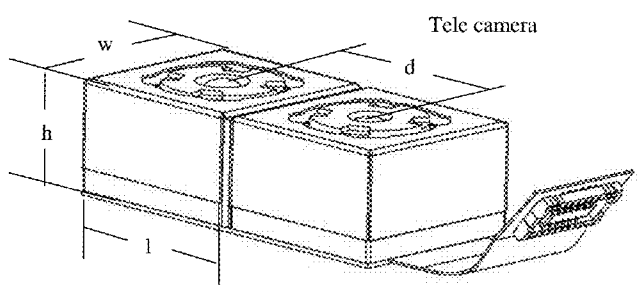

Tele camera
w
d
h
l

FIG. 1B

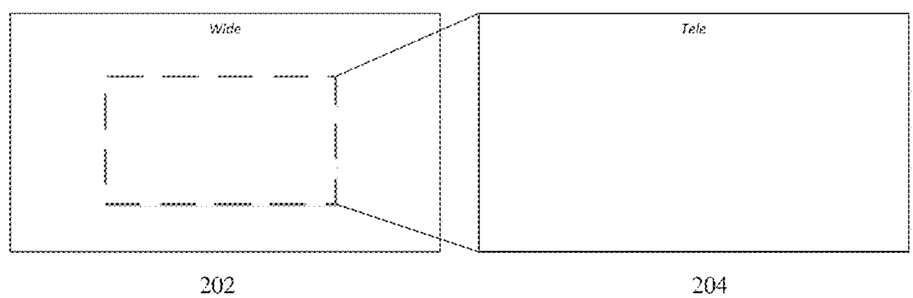


FIG. 2

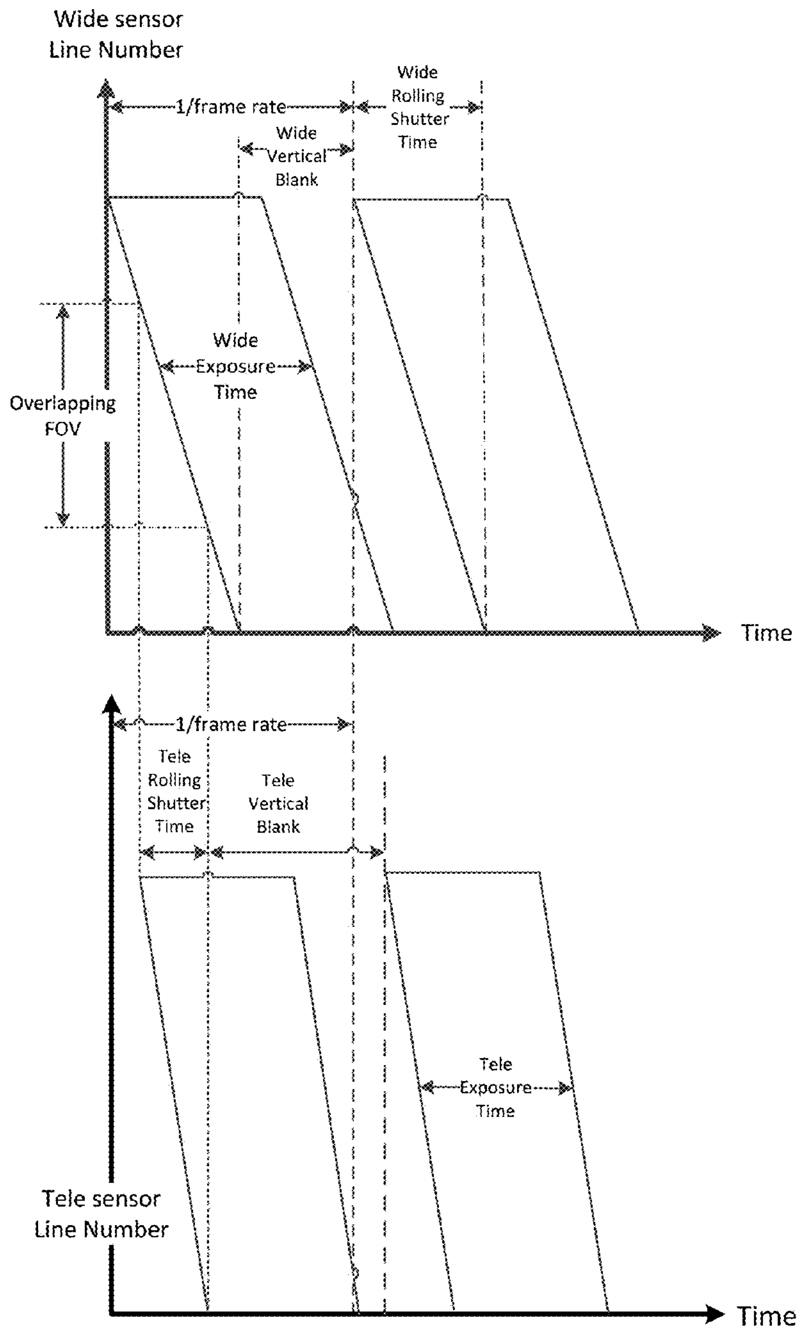

Wide sensor
Line Number
1/frame rate
Wide
Rolling
Shutter
Time
Wide
Vertical
Blank
Wide
Exposure
Time
Overlapping
FOV
Time
1/frame rate
Tele
Rolling
Shutter
Time
Tele
Vertical
Blank
Tele
Exposure
Time
Tele sensor
Line Number
Time

FIG. 3

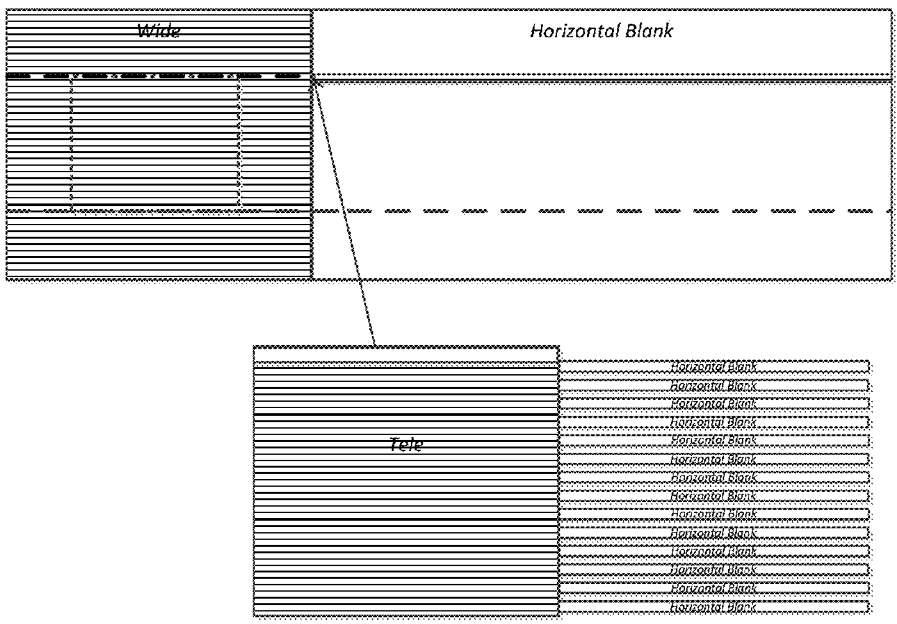


FIG. 4

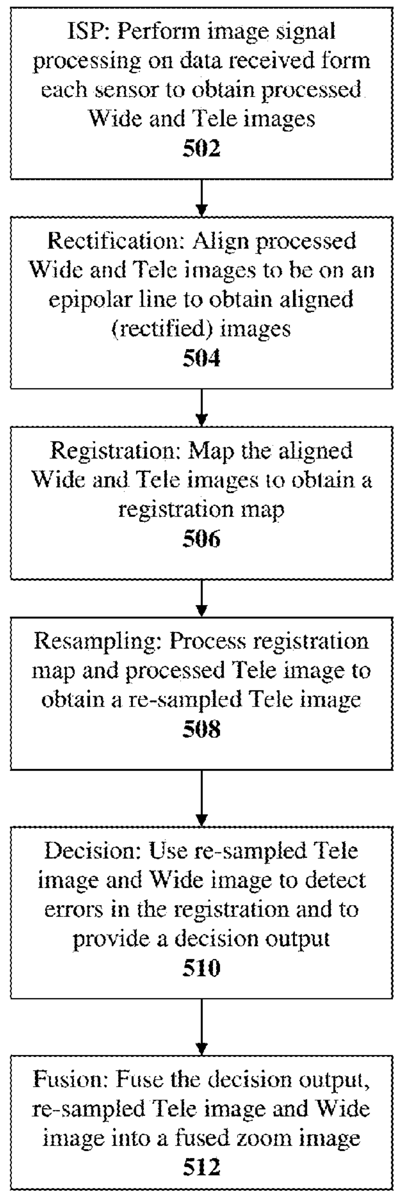
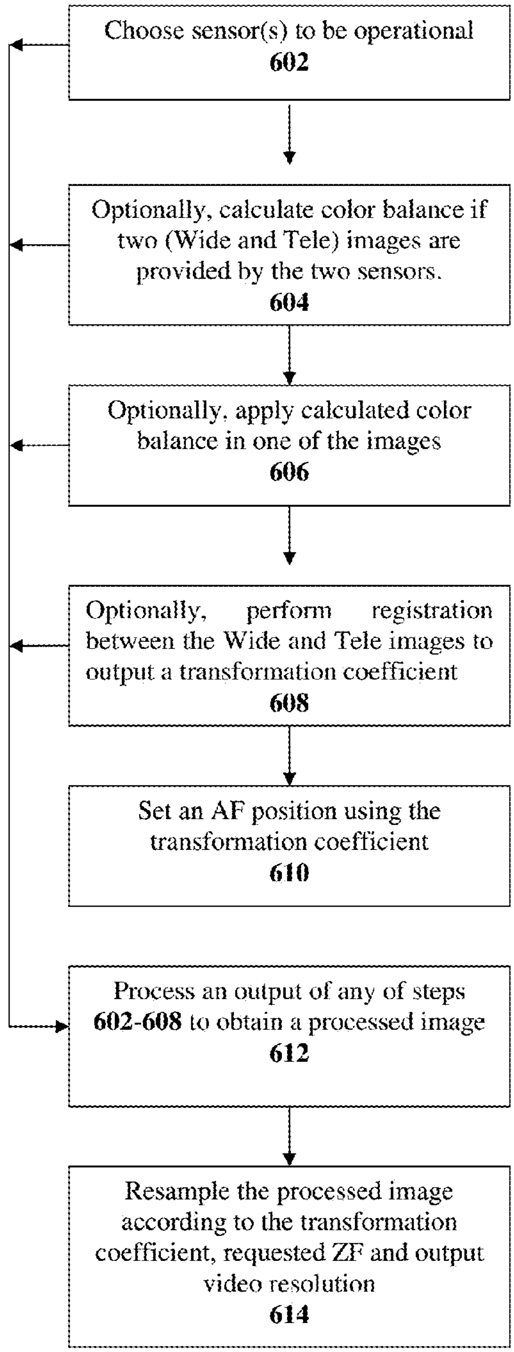

ISP: Perform image signal processing on data received form each sensor to obtain processed Wide and Tele images
502
Rectification: Align processed Wide and Tele images to be on an epipolar line to obtain aligned (rectified) images
504
Registration: Map the aligned Wide and Tele images to obtain a registration map
506
Resampling: Process registration map and processed Tele image to obtain a re-sampled Tele image
508
Decision: Use re-sampled Tele image and Wide image to detect errors in the registration and to provide a decision output
510
Fusion: Fuse the decision output, re-sampled Tele image and Wide image into a fused zoom image
512

FIG. 5



Choose sensor(s) to be operational
602
Optionally, calculate color balance if two (Wide and Tele) images are provided by the two sensors.
604
Optionally, apply calculated color balance in one of the images
606
Optionally, perform registration between the Wide and Tele images to output a transformation coefficient
608
Set an AF position using the transformation coefficient
610
Process an output of any of steps 602-608 to obtain a processed image
612
Resample the processed image according to the transformation coefficient, requested ZF and output video resolution
614

FIG. 6

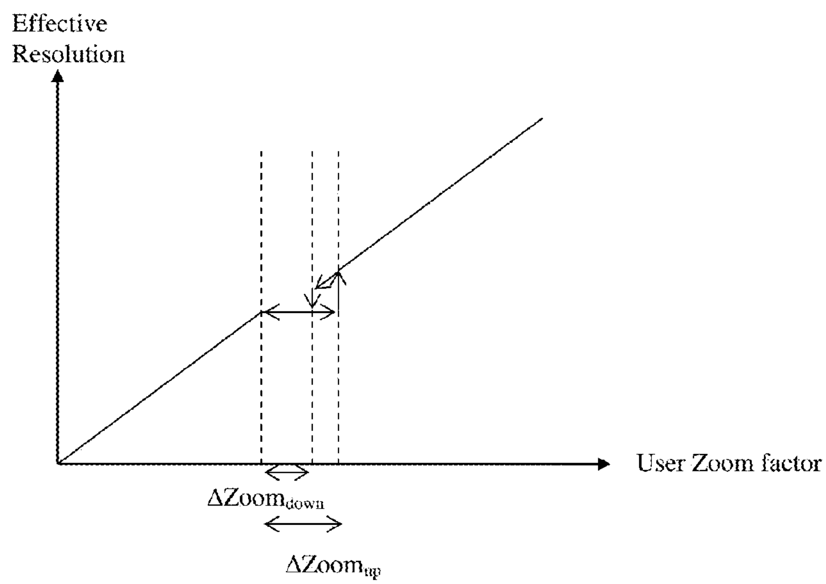


FIG. 7

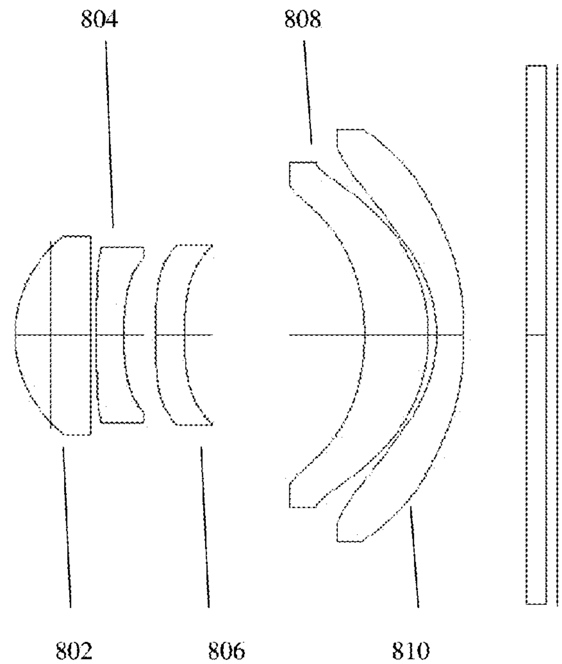


FIG. 8

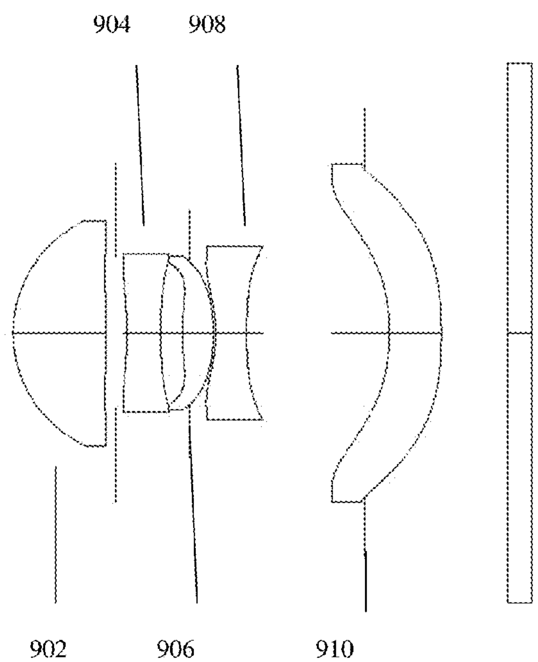


FIG. 9

DUAL APERTURE ZOOM DIGITAL CAMERA

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a Continuation application of U.S. patent application Ser. No. 14/880,251 filed Oct. 11, 2015 (now allowed), which was a Continuation application of U.S. patent application Ser. No. 14/365,711 filed Jun. 16, 2014 (issued as U.S. Pat. No. 9,185,291), which was a 371 application from international patent application PCT/IB2014/062180 filed Jun. 12, 2014, and is related to and claims priority from U.S. Provisional Patent Application No. 61/834,486 having the same title and filed Jun. 13, 2013, which is incorporated herein by reference in its entirety.

FIELD

Embodiments disclosed herein relate in general to digital cameras and in particular to thin zoom digital cameras with both still image and video capabilities

BACKGROUND

Digital camera modules are currently being incorporated into a variety of host devices. Such host devices include cellular telephones, personal data assistants (PDAs), computers, and so forth. Consumer demand for digital camera modules in host devices continues to grow.

Host device manufacturers prefer digital camera modules to be small, so that they can be incorporated into the host device without increasing its overall size. Further, there is an increasing demand for such cameras to have higher-performance characteristics. One such characteristic possessed by many higher-performance cameras (e.g., standalone digital still cameras) is the ability to vary the focal length of the camera to increase and decrease the magnification of the image. This ability, typically accomplished with a zoom lens, is known as optical zooming. "Zoom" is commonly understood as a capability to provide different magnifications of the same scene and/or object by changing the focal length of an optical system, with a higher level of zoom associated with greater magnification and a lower level of zoom associated with lower magnification. Optical zooming is typically accomplished by mechanically moving lens elements relative to each other. Such zoom lenses are typically more expensive, larger and less reliable than fixed focal length lenses. An alternative approach for approximating the zoom effect is achieved with what is known as digital zooming. With digital zooming, instead of varying the focal length of the lens, a processor in the camera crops the image and interpolates between the pixels of the captured image to create a magnified but lower-resolution image.

Attempts to use multi-aperture imaging systems to approximate the effect of a zoom lens are known. A multi-aperture imaging system (implemented for example in a digital camera) includes a plurality of optical sub-systems (also referred to as "sub-cameras"). Each sub-camera includes one or more lenses and/or other optical elements which define an aperture such that received electro-magnetic radiation is imaged by the optical sub-system and a resulting image is directed towards a two-dimensional (2D) pixelated image sensor region. The image sensor (or simply "sensor") region is configured to receive the image and to generate a set of image data based on the image. The digital camera may be aligned to receive electromagnetic radiation associated with scenery having a given set of one or more objects. The set of image data may be represented as digital image data, as well known in the art. Hereinafter in this description, "image" "image data" and "digital image data" may be used interchangeably. Also, "object" and "scene" may be used interchangeably.

Multi-aperture imaging systems and associated methods are described for example in US Patent Publications No. 2008/0030592, 2010/0277619 and 2011/0064327. In US 2008/0030592, two sensors are operated simultaneously to capture an image imaged through an associated lens. A sensor and its associated lens form a lens/sensor combination. The two lenses have different focal lengths. Thus, even though each lens/sensor combination is aligned to look in the same direction, each captures an image of the same subject but with two different fields of view (FOVs). One sensor is commonly called "Wide" and the other "Tele". Each sensor provides a separate image, referred to respectively as "Wide" (or "W") and "Tele" (or "T") images. A W-image reflects a wider FOV and has lower resolution than the T-image. The images are then stitched (fused) together to form a composite ("fused") image. In the composite image, the central portion is formed by the relatively higher-resolution image taken by the lens/sensor combination with the longer focal length, and the peripheral portion is formed by a peripheral portion of the relatively lower-resolution image taken by the lens/sensor combination with the shorter focal length. The user selects a desired amount of zoom and the composite image is used to interpolate values from the chosen amount of zoom to provide a respective zoom image. The solution offered by US 2008/0030592 requires, in video mode, very large processing resources in addition to high frame rate requirements and high power consumption (since both cameras are fully operational).

US 2010/0277619 teaches a camera with two lens/sensor combinations, the two lenses having different focal lengths, so that the image from one of the combinations has a FOV approximately 2-3 times greater than the image from the other combination. As a user of the camera requests a given amount of zoom, the zoomed image is provided from the lens/sensor combination having a FOV that is next larger than the requested FOV. Thus, if the requested FOV is less than the smaller FOV combination, the zoomed image is created from the image captured by that combination, using cropping and interpolation if necessary. Similarly, if the requested FOV is greater than the smaller FOV combination, the zoomed image is created from the image captured by the other combination, using cropping and interpolation if necessary. The solution offered by US 2010/0277619 leads to parallax artifacts when moving to the Tele camera in video mode.

In both US 2008/0030592 and US 2010/0277619, different focal length systems cause Tele and Wide matching FOVs to be exposed at different times using CMOS sensors. This degrades the overall image quality. Different optical F numbers ("F#") cause image intensity differences. Working with such a dual sensor system requires double bandwidth support, i.e. additional wires from the sensors to the following HW component. Neither US 2008/0030592 nor US 2010/0277619 deal with registration errors. Neither US2008/000592 nor US 2010/0277619 refer to partial fusion, i.e. fusion of less than all the pixels of both Wide and Tele images in still mode.

US 2011/0064327 discloses multi-aperture imaging systems and methods for image data fusion that include providing first and second sets of image data corresponding to an imaged first and second scene respectively. The scenes

overlap at least partially in an overlap region, defining a first collection of overlap image data as part of the first set of image data, and a second collection of overlap image data as part of the second set of image data. The second collection of overlap image data is represented as a plurality of image data sub-cameras such that each of the sub-cameras is based on at least one characteristic of the second collection, and each sub-camera spans the overlap region. A fused set of image data is produced by an image processor, by modifying the first collection of overlap image data based on at least a selected one of, but less than all of, the image data sub-cameras. The systems and methods disclosed in this application deal solely with fused still images.

None of the known art references provide a thin (e.g. fitting in a cell-phone) dual-aperture zoom digital camera with fixed focal length lenses, the camera configured to operate in both still mode and video mode to provide still and video images, wherein the camera configuration uses partial or full fusion to provide a fused image in still mode and does not use any fusion to provide a continuous, smooth zoom in video mode.

Therefore there is a need for, and it would be advantageous to have thin digital cameras with optical zoom operating in both video and still mode that do not suffer from commonly encountered problems and disadvantages, some of which are listed above.

SUMMARY

Embodiments disclosed herein teach the use of dual-aperture (also referred to as dual-lens or two-sensor) optical zoom digital cameras. The cameras include two sub-cameras, a Wide sub-camera and a Tele sub-camera, each sub-camera including a fixed focal length lens, an image sensor and an image signal processor (ISP). The Tele sub-camera is the higher zoom sub-camera and the Wide sub-camera is the lower zoom sub-camera. In some embodiments, the lenses are thin lenses with short optical paths of less than about 9 mm. In some embodiments, the thickness/effective focal length (EFL) ratio of the Tele lens is smaller than about 1. The image sensor may include two separate 2D pixelated sensors or a single pixelated sensor divided into at least two areas. The digital camera can be operated in both still and video modes. In still mode, zoom is achieved "with fusion" (full or partial), by fusing W and T images, with the resulting fused image including always information from both W and T images. Partial fusion may be achieved by not using fusion in image areas where the Tele image is not focused. This advantageously reduces computational requirements (e.g. time).

In video mode, optical zoom is achieved "without fusion", by switching between the W and T images to shorten computational time requirements, thus enabling high video rate. To avoid discontinuities in video mode, the switching includes applying additional processing blocks, which include image scaling and shifting.

In order to reach optical zoom capabilities, a different magnification image of the same scene is captured (grabbed) by each camera sub-camera, resulting in FOV overlap between the two sub-cameras. Processing is applied on the two images to fuse and output one fused image in still mode. The fused image is processed according to a user zoom factor request. As part of the fusion procedure, up-sampling may be applied on one or both of the grabbed images to scale it to the image grabbed by the Tele sub-camera or to a scale defined by the user. The fusion or up-sampling may be applied to only some of the pixels of a sensor. Down-sampling can be performed as well if the output resolution is smaller than the sensor resolution.

The cameras and associated methods disclosed herein address and correct many of the problems and disadvantages of known dual-aperture optical zoom digital cameras. They provide an overall zoom solution that refers to all aspects: optics, algorithmic processing and system hardware (HW). The proposed solution distinguishes between video and still mode in the processing flow and specifies the optical requirements and HW requirements. In addition, it provides an innovative optical design that enables a low TTL/EFL ratio using a specific lens curvature order.

Due to the large focal length, objects that are in front or behind the plane of focus appear very blurry, and a nice foreground-to-background contrast is achieved. However, it is difficult to create such a blur using a compact camera with a relatively short focal length and small aperture size, such as a cell-phone camera. In some embodiments, a dual-aperture zoom system disclosed herein can be used to capture a shallow DOF photo (shallow compared with a DOF of a Wide camera alone), by taking advantage of the longer focal length of the Tele lens. The reduced DOF effect provided by the longer Tele focal length can be further enhanced in the final image by fusing data from an image captured simultaneously with the Wide lens. Depending on the distance to the object, with the Tele lens focused on a subject of the photo, the Wide lens can be focused to a closer distance than the subject so that objects behind the subject appear very blurry. Once the two images are captured, information from the out-of-focus blurred background in the Wide image is fused with the original Tele image background information, providing a blurrier background and even shallower DOF.

In an embodiment there is provided a zoom digital camera comprising a Wide imaging section that includes a fixed focal length Wide lens with a Wide FOV, a Wide sensor and a Wide image signal processor (ISP), the Wide imaging section operative to provide Wide image data of an object or scene; a Tele imaging section that includes a fixed focal length Tele lens with a Tele FOV that is narrower than the Wide FOV, a Tele sensor and a Tele ISP, the Tele imaging section operative to provide Tele image data of the object or scene; and a camera controller operatively coupled to the Wide and Tele imaging sections, the camera controller configured to combine in still mode at least some of the Wide and Tele image data to provide a fused output image of the object or scene from a particular point of view (POV), and to provide without fusion continuous zoom video mode output images of the object or scene, a camera controller operatively coupled to the Wide and Tele imaging sections, the camera controller configured to combine in still mode at least some of the Wide and Tele image data to provide a fused output image of the object or scene from a particular point of view and to provide without fusion continuous zoom video mode output images of the object or scene, each output image having a respective output resolution, wherein the video output images are provided with a smooth transition when switching between a lower zoom factor (ZF) value and a higher ZF value or vice versa, wherein at the lower ZF value the output resolution is determined by the Wide sensor, and wherein at the higher ZF value the output resolution is determined by the Tele sensor.

In an embodiment, the camera controller configuration to provide video output images with a smooth transition when switching between a lower ZF value and a higher ZF value or vice versa includes a configuration that uses at high ZF secondary information from the Wide camera and uses at

low ZF secondary information from the Tele camera. As used herein, "secondary information" refers to white balance gain, exposure time, analog gain and color correction matrix.

In a dual-aperture camera image plane, as seen by each sub-camera (and respective image sensor), a given object will be shifted and have different perspective (shape). This is referred to as point-of-view (POV). The system output image can have the shape and position of either sub-camera image or the shape or position of a combination thereof. If the output image retains the Wide image shape then it has the Wide perspective POV. If it retains the Wide camera position then it has the Wide position POV. The same applies for Tele images position and perspective. As used in this description, the perspective POV may be of the Wide or Tele sub-cameras, while the position POV may shift continuously between the Wide and Tele sub-cameras. In fused images, it is possible to register Tele image pixels to a matching pixel set within the Wide image pixels, in which case the output image will retain the Wide POV ("Wide fusion"). Alternatively, it is possible to register Wide image pixels to a matching pixel set within the Tele image pixels, in which case the output image will retain the Tele POV ("Tele fusion"). It is also possible to perform the registration after either sub-camera image is shifted, in which case the output image will retain the respective Wide or Tele perspective POV.

In an embodiment there is provided a method for obtaining zoom images of an object or scene in both still and video modes using a digital camera, the method comprising the steps of providing in the digital camera a Wide imaging section having a Wide lens with a Wide FOV, a Wide sensor and a Wide image signal processor (ISP), a Tele imaging section having a Tele lens with a Tele FOV that is narrower than the Wide FOV, a Tele sensor and a Tele ISP, and a camera controller operatively coupled to the Wide and Tele imaging sections; and configuring the camera controller to combine in still mode at least some of the Wide and Tele image data to provide a fused output image of the object or scene from a particular point of view, and to provide without fusion continuous zoom video mode output images of the object or scene, each output image having a respective output resolution, wherein the video mode output images are provided with a smooth transition when switching between a lower ZF value and a higher ZF value or vice versa, and wherein at the lower ZF value the output resolution is determined by the Wide sensor while at the higher ZF value the output resolution is determined by the Tele sensor.

BRIEF DESCRIPTION OF THE DRAWINGS

Non-limiting examples of embodiments disclosed herein are described below with reference to figures attached hereto that are listed following this paragraph. The drawings and descriptions are meant to illuminate and clarify embodiments disclosed herein, and should not be considered limiting in any way.

FIG. **1**A shows schematically a block diagram illustrating a dual-aperture zoom imaging system disclosed herein;

FIG. **1**B is a schematic mechanical diagram of the dual-aperture zoom imaging system of FIG. **1**A:

FIG. **2** shows an example of Wide sensor, Tele sensor and their respective FOVs;

FIG. **3** shows a schematically embodiment of CMOS sensor image grabbing vs. time;

FIG. **4** shows schematically a sensor time configuration which enables sharing one sensor interface using dual sensor zoom system;

FIG. **5** shows an embodiment of a method disclosed herein for acquiring a zoom image in capture mode;

FIG. **6** shows an embodiment of a method disclosed herein for acquiring a zoom image in video/preview mode;

FIG. **7** shows a graph illustrating an effective resolution zoom factor;

FIG. **8** shows one embodiment of a lens block in a thin camera disclosed herein;

FIG. **9** shows another embodiment of a lens block in a thin camera disclosed herein.

DETAILED DESCRIPTION

FIG. **1**A shows schematically a block diagram illustrating an embodiment of a dual-aperture zoom imaging system (also referred to as simply as "digital camera" or "camera") disclosed herein and numbered **100**. Camera **100** comprises a Wide imaging section ("sub-camera") that includes a Wide lens block **102**, a Wide image sensor **104** and a Wide image processor **106**. Camera **100** further comprises a Tele imaging section ("sub-camera") that includes a Tele lens block **108**, a Tele image sensor **110** and a Tele image processor **112**. The image sensors may be physically separate or may be part of a single larger image sensor. The Wide sensor pixel size can be equal to or different from the Tele sensor pixel size. Camera **100** further comprises a camera fusion processing core (also referred to as "controller") **114** that includes a sensor control module **116**, a user control module **118**, a video processing module **126** and a capture processing module **128**, all operationally coupled to sensor control block **110**. User control module **118** comprises an operational mode function **120**, a region of interest (ROI) function **122** and a zoom factor (ZF) function **124**.

Sensor control module **116** is connected to the two sub-cameras and to the user control module **118** and used to choose, according to the zoom factor, which of the sensors is operational and to control the exposure mechanism and the sensor readout. Mode choice function **120** is used for choosing capture/video modes. ROI function **122** is used to choose a region of interest. As used herein, "ROI" is a user defined as a sub-region of the image that may be exemplarily 4% or less of the image area. The ROI is the region on which both sub-cameras are focused on. Zoom factor function **124** is used to choose a zoom factor. Video processing module **126** is connected to mode choice function **120** and used for video processing. Still processing module **128** is connected to the mode choice function **120** and used for high image quality still mode images. The video processing module is applied when the user desires to shoot in video mode. The capture processing module is applied when the user wishes to shoot still pictures.

FIG. **1**B is a schematic mechanical diagram of the dual-aperture zoom imaging system of FIG. **1**A. Exemplary dimensions: Wide lens TTL=4.2 mm and EFL=3.5 mm; Tele lens TTL=6 mm and EFL=7 mm; both Wide and Tele sensors ⅓ inch. External dimensions of Wide and Tele cameras: width (w) and length (l)=8.5 mm and height (h)=6.8 mm. Distance "d" between camera centers=10 mm.

Following is a detailed description and examples of different methods of use of camera **100**.

Design for Continuous and Smooth Zoom in Video Mode

In an embodiment, in order to reach high quality continuous and smooth optical zooming in video camera mode

while reaching real optical zoom using fixed focal length sub-cameras, the system is designed according to the following rules (Equations 1-3):

$$\mathrm{Tan}(\mathrm{FOV}_{Wide})/\mathrm{Tan}(\mathrm{FOV}_{Tele})=PL_{Wide}/PL_{video} \quad (1)$$

where Tan refers to "tangent", while FOV_{Wide} and FOV_{Tele} refer respectively to the Wide and Tele lens fields of view (in degrees). As used herein, the FOV is measured from the center axis to the corner of the sensor (i.e. half the angle of the normal definition). PL_{Wide} and PL_{video} refer respectively to the "in-line" (i.e. in a line) number of Wide sensor pixels and in-line number of output video format pixels. The ratio $\mathrm{PL}_{Wide}/\mathrm{PL}_{video}$ is called an "oversampling ratio". For example, in order to get full and continuous optical zoom experience with a 12 Mp sensor (sensor dimensions 4000×3000) and a required 1080 p (dimension 1920×1080) video format, the FOV ratio should be 4000/1920=2.083. Moreover, if the Wide lens FOV is given as $\mathrm{FOV}_{Wide}=37.5^{0}$, the required Tele lens FOV is 20.2^{0} The zoom switching point is set according to the ratio between sensor pixels in-line and the number of pixels in-line in the video format and defined as:

$$Z_{switch}=PL_{Wide}/PL_{video} \quad (2)$$

Maximum optical zoom is reached according to the following formula:

$$Z_{max}=\mathrm{Tan}(\mathrm{FOV}_{Wide})/\mathrm{Tan}(\mathrm{FOV}_{Tele})*PL_{Tele}/PL_{video} \quad (3)$$

For example: for the configuration defined above and assuming $\mathrm{PL}_{Tele}=4000$ and $\mathrm{PL}_{video}=1920$, $Z_{max}=4.35$.

In an embodiment, the sensor control module has a setting that depends on the Wide and Tele FOVs and on a sensor oversampling ratio, the setting used in the configuration of each sensor. For example, when using a 4000×3000 sensor and when outputting a 1920×1080 image, the oversampling ratio is 4000/1920=2.0833.

In an embodiment, the Wide and Tele FOVs and the oversampling ratio satisfy the condition

$$0.8*PL_{Wide}/PL_{video}<\mathrm{Tan}(\mathrm{FOV}_{Wide})/\mathrm{Tan}(\mathrm{FOV}_{Tele})<1.2*PL_{Wide}/PL_{video}. \quad (4)$$

Still Mode Operation/Function

In still camera mode, the obtained image is fused from information obtained by both sub-cameras at all zoom levels, see FIG. **2**, which shows a Wide sensor **202** and a Tele sensor **204** and their respective FOVs. Exemplarily, as shown, the Tele sensor FOV is half the Wide sensor FOV. The still camera mode processing includes two stages: (1) setting HW settings and configuration, where a first objective is to control the sensors in such a way that matching FOVs in both images (Tele and Wide) are scanned at the same time. A second objective is to control the relative exposures according to the lens properties. A third objective is to minimize the required bandwidth from both sensors for the ISPs; and (2) image processing that fuses the Wide and the Tele images to achieve optical zoom, improves SNR and provides wide dynamic range.

FIG. **3** shows image line numbers vs. time for an image section captured by CMOS sensors. A fused image is obtained by line (row) scans of each image. To prevent matching FOVs in both sensors to be scanned at different times, a particular configuration is applied by the camera controller on both image sensors while keeping the same frame rate. The difference in FOV between the sensors determines the relationship between the rolling shutter time and the vertical blanking time for each sensor. In the particular configuration, the scanning is synchronized such that the same points of the object in each view are obtained simultaneously.

Specifically with reference to FIG. **3** and according to an embodiment of a method disclosed herein, the configuration to synchronize the scanning includes: setting the Tele sensor vertical blanking time VB_{Tele} to equal the Wide sensor vertical blanking time VB_{Wide} plus half the Wide sensor rolling shutter time RST_{Wide}; setting the Tele and Wide sensor exposure times ET_{Tele} and ET_{Wide} to be equal or different; setting the Tele sensor rolling shutter time RST_{Tele} to be $0.5*\mathrm{RST}_{Wide}$; and setting the frame rates of the two sensors to be equal. This procedure results in identical image pixels in the Tele and Wide sensor images being exposed at the same time

In another embodiment, the camera controller synchronizes the Wide and Tele sensors so that for both sensors the rolling shutter starts at the same time.

The exposure times applied to the two sensors could be different, for example in order to reach same image intensity using different F# and different pixel size for the Tele and Wide systems. In this case, the relative exposure time may be configured according to the formula below:

$$\mathrm{ET}_{Tele}=\mathrm{ET}_{Wide}\cdot(F\#_{Tele}/F\#_{Wide})^{2}\cdot(\text{Pixel size}_{Wide}/\text{Pixel size}_{Tele})^{2} \quad (5)$$

Other exposure time ratios may be applied to achieve wide dynamic range and improved SNR. Fusing two images with different intensities will result in wide dynamic range image.

In more detail with reference to FIG. **3**, in the first stage, after the user chooses a required zoom factor ZF, the sensor control module configures each sensor as follows:

1) Cropping index Wide sensor:

$$Y_{Wide\ start}=1/2\cdot PC_{Wide}(1-1/\mathrm{ZF})$$

$$Y_{Wide\ end}=1/2\cdot PC_{Wide}(1+1/\mathrm{ZF})$$

where PC is the number of pixels in a column, and Y is the row number

2) Cropping index Tele sensor:

If ZF>Tan (FOV_{Wide})/Tan (FOV_{Tele}), then

$$Y_{Tele\ start}=1/2\cdot PC_{Tele}(1-(1/\mathrm{ZF})\cdot\mathrm{Tan}(\mathrm{FOV}_{Tele})/\mathrm{Tan}(\mathrm{FOV}_{Wide}))$$

$$Y_{Tele\ end}=1/2\cdot PC_{Tele}(1+(1/\mathrm{ZF})\cdot\mathrm{Tan}(\mathrm{FOV}_{Tele})/\mathrm{Tan}(\mathrm{FOV}_{Wide}))$$

If ZF<Tan (FOV_{Wide})/Tan (FOV_{Tele}), then

$$Y_{Tele\ start}=0$$

$$Y_{Tele\ end}=PC_{Tele}$$

This will result in an exposure start time of the Tele sensor with a delay of (in numbers of lines, relative to the Wide sensor start time):

$$(1-\mathrm{ZF}/((\mathrm{Tan}(\mathrm{FOV}_{Wide})/\mathrm{Tan}(\mathrm{FOV}_{Tele}))))\cdot 1/(2\cdot\mathrm{FPS}) \quad (6)$$

where FPS is the sensor's frame per second configuration. In cases where ZF>Tan (FOV_{Wide})/Tan (FOV_{Tele}), no delay will be introduced between Tele and Wide exposure starting point. For example, for a case where Tan (FOV_{Wide})/Tan $(\mathrm{FOV}_{Tele})=2$ and ZF=1, the Tele image first pixel is exposed 1/4·(1/FPS) second after the Wide image first pixel was exposed.

After applying the cropping according to the required zoom factor, the sensor rolling shutter time and the vertical blank should be configured in order to satisfy the equation to keep the same frame rate:

$$\mathrm{VB}_{Wide}+\mathrm{RST}_{Wide}=\mathrm{VB}_{Tele}+\mathrm{RST}_{Tele} \quad (7)$$

FIG. **3** exemplifies Eq. (7), One way to satisfy Eq. (7) is to increase the RST_{Wide}. Controlling the RST_{Wide} may be done by changing the horizontal blanking (HB) of the Wide sensor. This will cause a delay between the data coming out from each row of the Wide sensor.

Generally, working with a dual-sensor system requires multiplying the bandwidth to the following block, for example the ISP. For example, using 12 Mp working at 30 fps, 10 bit per pixel requires working at 3.6 Gbit/sec. In this example, supporting this bandwidth requires 4 lanes from each sensor to the respective following ISP in the processing chain. Therefore, working with two sensors requires double bandwidth (7.2 Gbit/sec) and 8 lanes connected to the respective following blocks. The bandwidth can be reduced by configuring and synchronizing the two sensors. Consequently, the number of lanes can be half that of a conventional configuration (3.6 Gbit/sec).

FIG. **4** shows schematically a sensor time configuration that enables sharing one sensor interface using a dual-sensor zoom system, while fulfilling the conditions in the description of FIG. **3** above. For simplicity, assuming the Tele sensor image is magnified by a factor of 2 compared with the Wide sensor image, the Wide sensor horizontal blanking time HB_{Wide} is set to twice the Wide sensor line readout time. This causes a delay between output Wide lines. This delay time matches exactly the time needed to output two lines from the Tele sensor. After outputting two lines from the Tele sensor, the Tele sensor horizontal blanking time HB_{Tele} is set to be one Wide line readout time, so, while the Wide sensor outputs a row from the sensor, no data is being output from the Tele sensor. For this example, every 3^{rd} line in the Tele sensor is delayed by an additional HB_{Tele}. In this delay time, one line from the Wide sensor is output from the dual-sensor system. After the sensor configuration stage, the data is sent in parallel or by using multiplexing into the processing section.

FIG. **5** shows an embodiment of a method disclosed herein for acquiring a zoom image in still mode. In ISP step **502**, the data of each sensor is transferred to the respective ISP component, which performs on the data various processes such as denoising, demosaicing, sharpening, scaling, etc, as known in the art. After the processing in step **502**, all following actions are performed in capture processing core **128**: in rectification step **504**, both Wide and Tele images are aligned to be on the epipolar line; in registration step **506**, mapping between the Wide and the Tele aligned images is performed to produce a registration map; in resampling step **508**, the Tele image is resampled according to the registration map, resulting in a re-sampled Tele image; in decision step **510**, the re-sampled Tele image and the Wide image are processed to detect errors in the registration and to provide a decision output. In more detail, in step **510**, the re-sampled Tele image data is compared with the Wide image data and if the comparison detects significant dissimilarities, an error is indicated. In this case, the Wide pixel values are chosen to be used in the output image. Then, in fusion step **512**, the decision output, re-sampled Tele image and the Wide image are fused into a single zoom image.

To reduce processing time and power, steps **506**, **508**, **510**, **512** could be bypassed by not fusing the images in non-focused areas. In this case, all steps specified above should be applied on focused areas only. Since the Tele optical system will introduce shallower depth of field than the Wide optical system, defocused areas will suffer from lower contrast in the Tele system.

Zoom-in and Zoom-Out in Still Camera Mode

We define the following: TFOV=tan (camera FOV/2). "Low ZF" refers to all ZF that comply with ZF<Wide TFOV/Tele TFOV. "High ZF" refers to all ZF that comply with ZF>Wide TFOV/Tele TFOV. "ZFT" refers to a ZF that complies with ZF=Wide TFOV/Tele TFOV. In one embodiment, zoom-in and zoom-out in still mode is performed as follows:

Zoom-in: at low ZF up to slightly above ZFT, the output image is a digitally zoomed, Wide fusion output. For the up-transfer ZF, the Tele image is shifted and corrected by global registration (GR) to achieve smooth transition. Then, the output is transformed to a Tele fusion output. For higher (than the up-transfer) ZF, the output is the Tele fusion output digitally zoomed.

Zoom-out: at high ZF down to slightly below ZFT, the output image is a digitally zoomed, Tele fusion output. For the down-transfer ZF, the Wide image is shifted and corrected by GR to achieve smooth transition. Then, the output is transformed to a Wide fusion output. For lower (than the down-transfer) ZF, the output is basically the down-transfer ZF output digitally zoomed but with gradually smaller Wide shift correction, until for ZF=1 the output is the unchanged Wide camera output.

In another embodiment, zoom-in and zoom-out in still mode is performed as follows:

Zoom-in: at low ZF up to slightly above ZFT, the output image is a digitally zoomed, Wide fusion output. For the up-transfer ZF and above, the output image is the Tele fusion output.

Zoom-out: at high ZF down to slightly below ZFT, the output image is a digitally zoomed, Tele fusion output. For the down-transfer ZF and below, the output image is the Wide fusion output.

Video Mode Operation/Function

Smooth Transition

When a dual-aperture camera switches the camera output between sub-cameras or points of view, a user will normally see a "jump" (discontinuous) image change. However, a change in the zoom factor for the same camera and POV is viewed as a continuous change. A "smooth transition" is a transition between cameras or POVs that minimizes the jump effect. This may include matching the position, scale, brightness and color of the output image before and after the transition. However, an entire image position matching between the sub-camera outputs is in many cases impossible, because parallax causes the position shift to be dependent on the object distance. Therefore, in a smooth transition as disclosed herein, the position matching is achieved only in the ROI region while scale brightness and color are matched for the entire output image area.

Zoom-In and Zoom-Out In Video Mode

In video mode, sensor oversampling is used to enable continuous and smooth zoom experience. Processing is applied to eliminate the changes in the image during cross-over from one sub-camera to the other. Zoom from 1 to Z_{switch} is performed using the Wide sensor only. From Z_{switch} and on, it is performed mainly by the Tele sensor. To prevent "jumps" (roughness in the image), switching to the Tele image is done using a zoom factor which is a bit higher ($Z_{switch}+\Delta Zoom$) than Z_{switch}. $\Delta Zoom$ is determined according to the system's properties and is different for cases where zoom-in is applied and cases where zoom-out is applied ($\Delta Zoom_{in} \neq \Delta Zoom_{out}$). This is done to prevent residual jumps artifacts to be visible at a certain zoom factor. The switching between sensors, for an increasing zoom and for decreasing zoom, is done on a different zoom factor.

The zoom video mode operation includes two stages: (1) sensor control and configuration, and (2) image processing. In the range from 1 to Z_{switch}, only the Wide sensor is operational, hence, power can be supplied only to this sensor. Similar conditions hold for a Wide AF mechanism. From Z_{switch}+ΔZoom to Z_{max} only the Tele sensor is operational, hence, power is supplied only to this sensor. Similarly, only the Tele sensor is operational and power is supplied only to it for a Tele AF mechanism. Another option is that the Tele sensor is operational and the Wide sensor is working in low frame rate. From Z_{switch} to Z_{switch}+ΔZoom, both sensors are operational.

Zoom-in: at low ZF up to slightly above ZFT, the output image is the digitally zoomed, unchanged Wide camera output. For the up-transfer ZF, the output is a transformed Tele sub-camera output, where the transformation is performed by a global registration (GR) algorithm to achieve smooth transition. For higher (than the up-transfer), the output is the transfer ZF output digitally zoomed.

Zoom-out: at high ZF down to slightly below ZFT, the output image is the digitally zoomed transformed Tele camera output. For the down-transfer ZF, the output is a shifted Wide camera output, where the Wide shift correction is performed by the GR algorithm to achieve smooth transition, i.e. with no jump in the ROI region. For lower (than the down-transfer) ZF, the output is basically the down-transfer ZF output digitally zoomed but with gradually smaller Wide shift correction, until for ZF=1 the output is the unchanged Wide camera output.

FIG. **6** shows an embodiment of a method disclosed herein for acquiring a zoom image in video/preview mode for 3 different zoom factor (ZF) ranges: (a) ZF range=1: Z_{switch}; (b) ZF range=Z_{switch}:Z_{switch}+ΔZoom$_{in}$: and (c) Zoom factor range=Z_{switch}+ΔZoom$_{in}$:Z_{max}. The description is with reference to a graph of effective resolution vs. zoom value (FIG. **7**). In step **602**, sensor control module **116** chooses (directs) the sensor (Wide, Tele or both) to be operational. Specifically, if the ZF range=1:Z_{switch}, module **116** directs the Wide sensor to be operational and the Tele sensor to be non-operational. If the ZF range is Z_{switch}: Z_{switch}+ΔZoom$_{in}$, module **116** directs both sensors to be operational and the zoom image is generated from the Wide sensor. If the ZF range is Z_{switch}+ΔZoom$_{in}$:Z_{max}, module **116** directs the Wide sensor to be non-operational and the Tele sensor to be operational. After the sensor choice in step **602**, all following actions are performed in video processing core **126**. Optionally, in step **604**, color balance is calculated if two images are provided by the two sensors. Optionally yet, in step **606**, the calculated color balance is applied in one of the images (depending on the zoom factor). Further optionally, in step **608**, registration is performed between the Wide and Tele images to output a transformation coefficient. The transformation coefficient can be used to set an AF position in step **610**. In step **612**, an output of any of steps **602**-**608** is applied on one of the images (depending on the zoom factor) for image signal processing that may include denoising, demosaicing, sharpening, scaling, etc. In step **614**, the processed image is resampled according to the transformation coefficient, the requested ZF (obtained from zoom function **124**) and the output video resolution (for example 1080 p). To avoid a transition point to be executed at the same ZF, ΔZoom can change while zooming in and while zooming out. This will result in hysteresis in the sensor switching point.

In more detail, for ZF range 1:Z_{switch}, for ZF<Z_{switch}, the Wide image data is transferred to the ISP in step **612** and resampled in step **614**. For ZF range=Z_{switch}:Z_{switch}+ΔZoom$_{in}$, both sensors are operational and the zoom image is generated from the Wide sensor. The color balance is calculated for both images according to a given ROI. In addition, for a given ROI, registration is performed between the Wide and Tele images to output a transformation coefficient. The transformation coefficient is used to set an AF position. The transformation coefficient includes the translation between matching points in the two images. This translation can be measured in a number of pixels. Different translations will result in a different number of pixel movements between matching points in the images. This movement can be translated into depth and the depth can be translated into an AF position. This enables to set the AF position by only analyzing two images (Wide & Tele). The result is fast focusing.

Both color balance ratios and transformation coefficient are used in the ISP step. In parallel, the Wide image is processed to provide a processed image, followed by resampling. For ZF range=Z_{switch}+ΔZoom$_{in}$:Z_{max} and for Zoom factor>Z_{switch}, +ΔZoom$_{in}$, the color balance calculated previously is now applied on the Tele image. The Tele image data is transferred to the ISP in step **612** and resampled in step **614**. To eliminate crossover artifacts and to enable smooth transition to the Tele image, the processed Tele image is resampled according to the transformation coefficient, the requested ZF (obtained from zoom function **124**) and the output video resolution (for example 1080 p).

FIG. **7** shows the effective resolution as a function of the zoom factor for a zoom-in case and for a a zoom-out case ΔZoom$_{up}$ is set when we zoom in, and ΔZoom$_{down}$ is set when we zoom out. Setting ΔZoom$_{up}$ to be different from ΔZoom$_{down}$ will result in transition between the sensors to be performed at different zoom factor ("hysteresis") when zoom-in is used and when zoom-out is used. This hysteresis phenomenon in the video mode results in smooth continuous zoom experience.

Optical Design

Additional optical design considerations were taken into account to enable reaching optical zoom resolution using small total track length (TTL). These considerations refer to the Tele lens. In an embodiment, the camera is "thin" (see also FIG. **1**B) in the sense that is has an optical path of less than 9 mm and a thickness/focal length (FP) ratio smaller than about 0.85. Exemplarily, as shown in FIG. **8**, such a thin camera has a lens block that includes (along an optical axis starting from an object) five lenses: a first lens element **802** with positive power and two lenses **804** and **806** and with negative power, a fourth lens **808** with positive power and a fifth lens **810** with negative power. In the embodiment of FIG. **8**, the EFL is 7 mm, the TTL is 4.7 mm, f=6.12 and FOV=20^{0}. Thus the Tele lens TTL/EFL ratio is smaller than 0.9. In other embodiments, the Tele lens TTL/EFL ratio may be smaller than 1.

In another embodiment of a lens block in a thin camera, shown in FIG. **9**, the camera has a lens block that includes (along an optical axis starting from an object) a first lens element **902** with positive power a second lens element **904** with negative power, a third lens element with positive power **906** and a fourth lens element with negative power **908**, and a fifth lens element **910** with positive or negative power. In this embodiment, f=7.14, F#=3.5, TTL=5.8 mm and FOV=22.7^{0}.

In conclusion, dual aperture optical zoom digital cameras and associate methods disclosed herein reduce the amount of processing resources, lower frame rate requirements, reduce power consumption, remove parallax artifacts and provide continuous focus (or provide loss of focus) when changing

from Wide to Tele in video mode. They provide a dramatic reduction of the disparity range and avoid false registration in capture mode. They reduce image intensity differences and enable work with a single sensor bandwidth instead of two, as in known cameras.

All patent applications mentioned in this specification are herein incorporated in their entirety by reference into the specification, to the same extent as if each individual patent application was specifically and individually indicated to be incorporated herein by reference. In addition, citation or identification of any reference in this application shall not be construed as an admission that such reference is available as prior art to the present disclosure.

While this disclosure has been described in terms of certain embodiments and generally associated methods, alterations and permutations of the embodiments and methods will be apparent to those skilled in the art. The disclosure is to be understood as not limited by the specific embodiments described herein, but only by the scope of the appended claims.

What is claimed is:

1. A zoom digital camera comprising:

a) a first imaging section that includes a fixed focal length first lens with a first field of view (FOV_1) and a first image sensor, the first imaging section operative to provide first image data of an object or scene;

b) a second imaging section that includes a fixed focal length second lens with a second FOV (FOV_2) that is narrower than FOV_1 and a second image sensor, the second imaging section operative to provide second image data of the object or scene; and

c) a camera controller operatively coupled to the first and second imaging sections, the camera controller configured to provide an output image having a focused subject, wherein the output image exhibits a shallow depth of focus (DOF) effect in which objects in front of or behind the focused subject appear blurry, wherein the focused subject is provided by the second lens and wherein the objects behind the focused subject appear blurry due to the first lens being focused to a closer distance than the subject.

2. The zoom digital camera of claim **1**, wherein the output image is a still mode output image.

3. The zoom digital camera of claim **1**, wherein, for a portrait photo, the output image exhibiting a shallow DOF effect is similar to a portrait photo taken with a digital single-lens reflex (DSLR) camera.

4. The zoom digital camera of claim **3**, wherein the DSLR has a focal length between 50-80 mm.

5. A zoom digital camera comprising:

a) a first imaging section that includes a fixed focal length first lens with a first field of view (FOV_1) and a first image sensor; and

b) a second imaging section that includes a fixed focal length second lens with a second FOV (FOV2) that is narrower than FOV, and a second image sensor, wherein the second lens includes five lens elements along an optical axis starting from an object starting with a first lens element with positive power, wherein the five lens elements further include a second lens element with negative power, a fourth lens element with negative power and a fifth lens element, wherein a largest distance between consecutive lens elements along the optical axis is a distance between the fourth lens element and the fifth lens element, and wherein a ratio of a total track length (TTL) to effective focal length (EFL) of the second lens is smaller than 1.

6. The zoom digital camera of claim **5**, further comprising a camera controller operatively coupled to the first and second imaging sections, the camera controller configured to provide video output images with a smooth transition when switching between a lower zoom factor (ZF) value and a higher ZF value or vice versa.

7. A zoom digital camera comprising:

a) a first imaging section that includes a fixed focal length first lens with a first field of view (FOV_1) and a first image sensor, the first imaging section operative to provide first image data of an object or scene;

b) a second imaging section that includes a fixed focal length second lens with a second FOV (FOV_2) that is narrower than FOV_1 and a second image sensor, the second imaging section operative to provide second image data of the object or scene; and

c) a camera controller operatively coupled to the first and second imaging sections, the camera controller configured to provide an output image having a focused subject, wherein the output image exhibits a shallow depth of focus (DOF) effect in which objects in front of or behind the focused subject appear blurry, wherein the shallow DOF effect is achieved by focusing the first lens on a distance closer than the subject to thereby obtain the first image data comprising out-of-focus blurred background image data, and focusing the second lens on the subject to obtain the second image data; and fusing the first image data with the second image data to increase blurriness of background of the output image.

* * * * *

Case: 22-2288   Document: 28   Page: 1   Filed: 11/09/2022

UNITED STATES COURT OF APPEALS
FOR THE FEDERAL CIRCUIT

APPLE INC.,
Petitioner/Appellant

Appeal No. 2022-2288

v.

COREPHOTONICS, LTD.,
Patent Owner/Appellee

Proceeding No.: IPR2020-00489

NOTICE FORWARDING CERTIFIED LIST

A Notice of Appeal to the United States Court of Appeals for the Federal Circuit was timely filed September 26, 2022, in the United States Patent and Trademark Office in connection with the above identified *Inter Partes Review* proceeding. Pursuant to 35 U.S.C. § 143, a Certified List is this day being forwarded to the Federal Circuit.

Respectfully submitted,

Date: November 8, 2022

By: Macia L. Fletcher
Macia L. Fletcher
Paralegal
Mail Stop 8
P.O. Box 1450
Alexandria, VA 22313-1450
571-272-9035

Under Secretary of Commerce for Intellectual Property and
Director of the United States Patent and Trademark Office

CERTIFICATE OF SERVICE

The undersigned hereby certifies that a true and correct copy of the foregoing NOTICE FORWARDING CERTIFIED LIST has been served, via electronic mail, on counsel for Appellant and Appellee this 8th day of November, 2022, as follows:

PETITIONER:	PATENT OWNER:
David L. McCombs Andrew S. Ehmke David W. O'Brien Angela M. Oliver Hong Shi HAYNES & BOONE, LLP david.mccombs.ipr@haynesboone.com andy.ehmke@haynesboone.com david.obrien@haynesboone.com angela.oliver@haynesboone.com hong.shi.ipr@haynesboone.com	Marc A. Fenster Neil Rubin James S. Tsuei RUSS AUGUST & KABAT mafenster@raklaw.com nrubin@raklaw.com jtsuei@raklaw.com

By: Macia L. Fletcher

Macia L. Fletcher
Paralegal
Mail Stop 8
P.O. Box 1450
Alexandria, VA 22313-1450
571-272-9035

U.S. DEPARTMENT OF COMMERCE
United States Patent and Trademark Office

November 8, 2022
(Date)

THIS IS TO CERTIFY that the attached document is a list of the papers that comprise the record before the Patent Trial and Appeal Board (PTAB) for the *Inter Partes Review* proceeding identified below.

APPLE INC.,
Petitioner,

v.

COREPHOTONICS, LTD.,
Patent Owner.

Case: IPR2020-00489
Patent No. 10,015,408 B2
By authority of the

DIRECTOR OF THE UNITED STATES
PATENT AND TRADEMARK OFFICE

Macia L. Fletcher
Certifying Officer

Prosecution History ~ IPR2020-00489

Date	Document
2/5/2020	Petition for Inter Partes Review
2/5/2020	Petitioner's Power of Attorney
2/5/2020	Petitioner's Notice for Filing Two Petitions
2/12/2020	Notice of Filing Date Accorded to Petition
5/8/2020	Patent Owner's Mandatory Notices
5/8/2020	Patent Owner's Power of Attorney
5/12/2020	Patent Owner's Preliminary Response
7/31/2020	Decision - Institution of Inter Partes Review
9/21/2020	Scheduling Order
10/26/2020	Notice of Deposition - Sasian, Ph.D.
10/28/2020	Amended Notice of Deposition - Sasian, Ph.D.
11/16/2020	Joint Stipulation to Modify Due Date 1 and Due Date 2
11/25/2020	Patent Owner's Response
11/26/2020	Patent Owner's Certification of Word Count for Patent Owner's Response to Petition for Inter Partes Review
3/2/2021	Petitioner's Updated Mandatory Notices
3/2/2021	Notice of Deposition - Moore, Ph.D.
3/4/2021	Joint Stipulation to Modify Due Dates 2 and 3
3/25/2021	Petitioner's Reply
4/6/2021	Notice of Deposition - Sasian, Ph.D.
4/23/2021	Patent Owner's Sur-Reply
4/30/2021	Patent Owner's Request for Oral Argument
4/30/2021	Petitioner's Request for Oral Argument
5/6/2021	Motion for Pro Hac Vice Admission - Fenster and Tsuei
5/10/2021	Order - Setting Oral Argument
5/11/2021	Order - Pro Hac Vice Admission - Fenster and Tsuei
5/17/2021	Joint Stipulation to Alternative Schedule for Serving Demonstratives and Request to Modify Schedule from that Set in Hearing Order
5/24/2021	Petitioner's Demonstratives for Oral Hearing
5/25/2021	Patent Owner's Oral Hearing Demonstratives
5/26/2021	Patent Owner's Objections to Petitioner's Oral Hearing Demonstratives
5/26/2021	Petitioner's Objections to Patent Owner's Demonstratives for Oral Hearing
7/12/2021	Oral Hearing Transcript
7/26/2021	Final Written Decision
8/25/2021	Patent Owner's Brief Regarding Admission of LG Innotek Brief into the Record
8/25/2021	Petitioner's Request For Rehearing
9/1/2021	Petitioner's Opposition to Patent Owner's Brief Regarding Good Cause for Admission of LG Innotek Brief Into Evidence
9/1/2021	Patent Owner's Brief Regarding Admission of Corephotonics Korean Brief into the Record
9/7/2021	Notification of Receipt of Precedential Opinion Panel (POP) Request
9/14/2021	Notification of Receipt of POP Request: Amicus Form
2/4/2022	Order - POP Request

Prosecution History ~ IPR2020-00489

Date	Document
5/12/2022	Panel Change Order - Conduct of the Proceeding
7/27/2022	Decision - Request for Rehearing

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

APPLE INC.,

Petitioner

v.

COREPHOTONICS LTD.,

Patent Owner

IPR2020-00489
U.S. Patent No. 10,015,408

PETITION FOR *INTER PARTES* REVIEW
UNDER 35 U.S.C. § 312 AND 37 C.F.R. § 42.104

TABLE OF CONTENTS

PETITIONER'S EXHIBIT LIST

APPL-1001	U.S. Patent No. 10,015,408 to Shabtay et al. (the "'408 Patent")
APPL-1002	Prosecution File History of the '408 Patent (the "'853 App")
APPL-1003	Declaration of Dr. José Sasián
APPL-1004	CV of Dr. José Sasián
APPL-1005	U.S. Patent Application Publication No. 2012/0026366 to Golan et al. ("Golan")
APPL-1006	Warren J. Smith, MODERN LENS DESIGN (1992) ("Smith")
APPL-1007	JP Patent Application Publication No. S58-62609 to Kawamura ("Kawamura"), English translation, Declaration, and Original
APPL-1008	U.S. Patent No. 7,777,972 to Chen et al. ("Chen")
APPL-1009	ZEMAX Development Corporation, ZEMAX Optical Design Program User's Manual, February 14, 2011 ("ZEMAX User's Manual")
APPL-1010	U.S. Patent 7,990,422 to Ahiska et al. ("Ahiska")
APPL-1011	U.S. Patent App. Pub. No. US2012/0314296 to Shabtay et al. ("Shabtay 296")
APPL-1012	U.S. Patent No. 8,553,106 to Scarff ("Scarff")
APPL-1013	RESERVED
APPL-1014	Japanese Patent Pub. No. JP2013106289 to Konno (Original)
APPL-1015	Japanese Patent Pub. No. JP2013106289 to Konno, Certified English translation ("Konno")

APPL-1016	Ralph E. Jacobson et al., The Manual of Photography: photographic and digital imaging, 9th Edition, 2000 (“Jacobson”)

I. INTRODUCTION

U.S. Patent No. 10,015,408 (the "'408 Patent," APPL-1001) is generally directed to a "dual aperture zoom digital camera." (APPL-1001), Title. Challenged claims 5-6 of the '408 Patent are directed to a zoom digital camera including 1) two imaging sections having respective image sensors and fixed focal length lenses with different fields of view (FOVs) and 2) the second lens of the second imaging section including five lens elements with specific power, distance, and TTL/EFL ratio configurations. As shown in this Petition, these concepts in a digital camera that uses multiple lenses and image sensors were known in the art before the priority date of the '408 patent.

This Petition, along with the cited evidence, demonstrates that claims 5-6 of the '408 Patent are rendered obvious under (post-AIA) 35 U.S.C. §103. Apple Inc. ("Petitioner") therefore respectfully requests that these claims be held unpatentable and cancelled.

II. MANDATORY NOTICES

A. Real Party-in-Interest

The real party-in-interest is Apple Inc.

B. Related Matters

As of the filing date of this Petition and to the best knowledge of Petitioner, the '408 Patent has been asserted in the following matters:

- *Corephotonics Ltd. v. Apple Inc.*, Case No. 5-19-cv-04809 (N.D. Cal. filed August 14, 2019).

Petitioner is also concurrently or contemporaneously filing a petition for inter partes review of claims 1-4 and 7 of the '408 Patent.

C. Lead and Back-up Counsel and Service Information

Lead Counsel David W. O'Brien HAYNES AND BOONE, LLP 600 Congress Ave. Suite 1300 Austin, TX 78701	Phone: 512-867-8457 Fax: 512-867-8644 david.obrien.ipr@haynesboone.com USPTO Reg. No. 40,107
Back-up Counsel Andrew S. Ehmke HAYNES AND BOONE, LLP 2323 Victory Ave. Suite 700 Dallas, TX 75219	Phone: 214-651-5116 Fax: 214-200-0853 andy.ehmke.ipr@haynesboone.com USPTO Reg. No. 50,271
Hong Shi HAYNES AND BOONE, LLP 600 Congress Ave. Suite 1300 Austin, TX 78701	Phone: 512-867-8440 Fax: 512-867-8644 hong.shi.ipr@haynesboone.com USPTO Reg. No. 69,009

Please address all correspondence to lead and back-up counsel. Petitioner consents to electronic service.

III. GROUNDS FOR STANDING

Pursuant to 37 C.F.R. §42.104(a), Petitioner certifies that the '408 Patent is available for *inter partes* review and that Petitioner is not barred or estopped from requesting an *inter partes* review challenging the patent claims on the grounds identified in this Petition.

IV. THE '408 PATENT

A. Summary

The '408 Patent is titled "Dual Aperture Zoom Digital Camera" and was issued on July 3, 2018. (APPL-1001), '408 Patent, Title. The '408 Patent is directed to a "dual-aperture zoom digital camera operable in both still and video modes." (APPL-1001), '408 Patent, Abstract. (APPL-1003), Sasián, ¶¶28-34.

In its background, the '408 Patent acknowledges that using digital zooming is an "alternative approach [to optical zooming] for approximating the zoom effect," and use of "**multi-aperture** imaging systems to approximate the effect of a zoom lens **are known**." (APPL-1001), '408 Patent, 1:46-51, 1:55-56. For example, the '408 Patent acknowledges that US Patent Application Publication No. 2008/0030592 to Border et al. ("Border") describe a digital camera including "two lenses having different focal lengths," but alleges that Border "requires, in video mode, very large processing resources in addition to high frame rate requirements and high power consumption (since both cameras are fully operational)." (APPL-1001), '408 Patent, 2:7-34. For further example, the '408 Patent acknowledges that US Patent Application Publication No. 2010/0277619 to Scarff ("Scarff") describes a camera with two lens/sensor combinations to provide a zoomed image based on a zoom amount requested by a user, but alleges that Scarff "leads to parallax artifacts when moving to the Tele camera in video mode." (APPL-1001),

’408 Patent, 2:35-51.

“[T]o address and correct many of the problems and disadvantages of known dual-aperture optical zoom digital cameras,” the ’408 Patent alleges that it provides “an overall zoom solution that refers to all aspects: optics, algorithmic processing and system hardware (HW). The proposed solution distinguishes between video and still mode in the processing flow and specifies the optical requirements and HW requirements. In addition, it provides an innovative optical design that enables a low TTL/EFL ratio using a specific lens curvature order.” (APPL-1001), ’408 patent, 4:3-12.

Specifically, the ’408 Patent describes that “optical design considerations were taken into account to enable reaching optical zoom resolution using small total track length (TTL),” which “refer to the Tele lens.” (APPL-1001), ’408 patent, 12:38-41.

The ’408 Patent provides two embodiments of the Tele lens illustrated in FIGS. 8 and 9 respectively, which are reproduced below. The embodiment of FIG. 8 includes “a fourth lens 808 with positive power,” while claim 5 requires a fourth lens element with negative power. (APPL-1001), ’408 patent, 12:48.

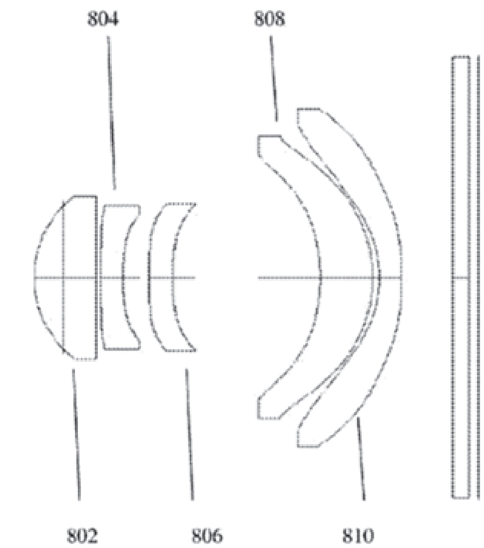


FIG. 8

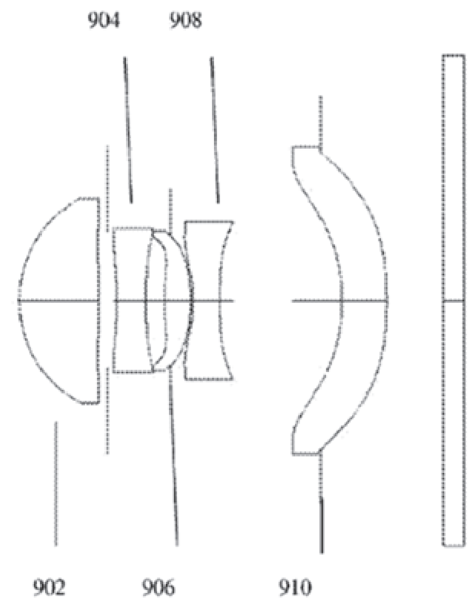


FIG. 9

(APPL-1001), ’408 Patent, FIGS. 8 and 9

Regarding the embodiment of FIG. 9, the ’408 Patent describes that “the camera has a lens block that includes (along an optical axis starting from an object) a first lens element 902 with positive power a second lens element 904 with negative power, a third lens element with positive power 906 and a fourth lens element with negative power 908, and a fifth lens element 910 with positive or negative power. In this embodiment, f=7.14, F#=3.5, TTL=5.8 mm and FOV=22.70°.” (APPL-1001), ’408 Patent, 12:54-62. It is noted that the ’408 Patent does not provide a lens prescription table (including e.g., axial distances, radii of curvature, Abbe numbers, etc.).

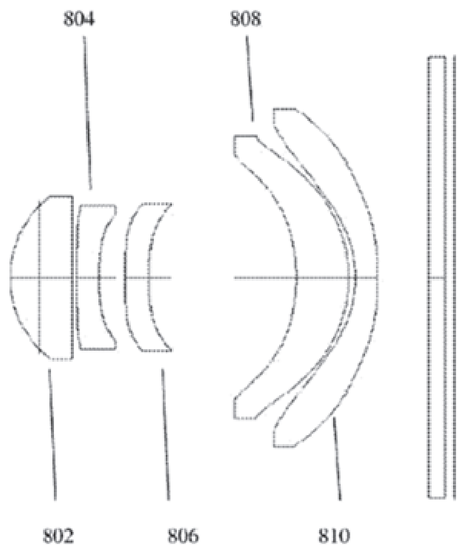


FIG. 8

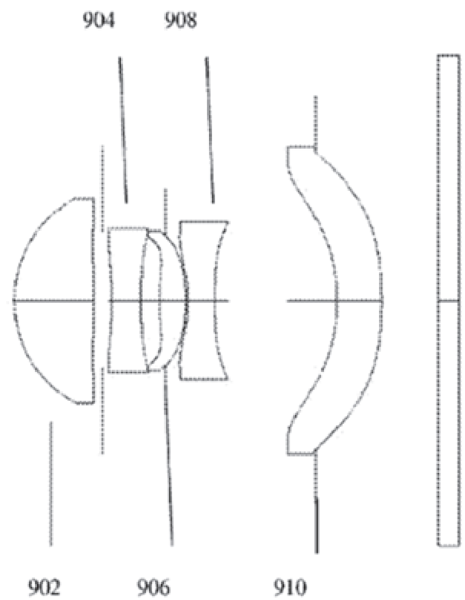


FIG. 9

(APPL-1001), '408 Patent, FIGS. 8 and 9

Regarding the embodiment of FIG. 9, '408 Patent describes that "the camera has a lens block that includes (along an optical axis starting from an object) a first lens element 902 with positive power a second lens element 904 with negative power, a third lens element with positive power 906 and a fourth lens element with negative power 908, and a fifth lens element 910 with positive or negative power. In this embodiment, f=7.14, F#=3.5, TTL=5.8 mm and FOV=22.70°." '408 Patent, 12:54-62. The '408 Patent does not provide a table including lens data (e.g., axial distance, radius of curvature, Abbe number, etc.) for either embodiment of FIGS. 8 and 9.

As demonstrated in detail below, however, and confirmed in testimonies of Dr. José Sasián (APPL-1003), it was well-known in the art, before the earliest

claimed priority date of the ’408 Patent, to provide a zoom digital camera using 1) first and second imaging sections with respective first and second lenses and image sensors, and 2) the second lens including five lens elements with specific power, distance, and TTL/EFL ratio configurations. (APPL-1003), Sasián, ¶34.

B. Prosecution History

The summary of prosecution history below is focused on claims 8, 9, and 11 in the prosecution history, where claims 9 and 11 issued as claims 5 and 6 respectively. (APPL-1003), Sasián, ¶¶35-42.

Specifically, in notice of allowance, Examiner’s amendment canceled claim 8, amended claim 9, and added claim 11. (APPL-1002), ’853 App, 164-167. Claims 9 and 11 issued as claims 5 and 6 respectively.

On February 5th, 2017, the Applicant filed U.S. Patent Application No. 15/424853 (“the ’853 App”) including claims 1-9, which ultimately issued as the ’408 Patent. (APPL-1002), ’853 App, 1-39.

In the Office Action mailed April 7, 2017, the Examiner rejected claims 8-9 as unpatentable over U.S. Patent App. Pub. No. 2008/0030592 to Border et al. (“Border”) in view of U.S. Patent App. Pub. No. 2012/0314296 to Shabtay et al. (“Shabtay ’296”). (APPL-1002), ’853 App, 74-75.

In the response filed July 17, 2017, the Applicant did not amend claims 8-9, but argued that Shabtay ’296 does not teach, and in fact, teaches away from the required TTL to EFL ratio as claimed. (APPL-1002), ’853 App, 96.

In the Office Action of October 12, 2017, the Examiner indicated that claims 8-9 are allowed. ’853 App, 115. In the response filed October 19, 2017, the Applicant amended claim 9 to change “a fifth lens element with positive or negative power” to “a fifth lens element with positive power.” (APPL-1002), ’853 App, 134.

On January 5, 2018, an examiner interview was conducted to discuss amendments for claims 8-9 to distinguish prior art JP2013/106289 and US Patent No. 9,405,099 to Jo and add new claim 11. (APPL-1002), ’853 App, 170.

On February 9, 2018, a notice of allowance issued, including an examiner’s amendment to cancel claim 8, amend claim 9, and add a new claim 11. (APPL-1002), ’853 App, 159-169.

The ’408 Patent issued on June 13, 2018. The allowed claims 9 and 11 were issued as claims 5 and 6 of the ’408 Patent, respectively.

V. LEVEL OF ORDINARY SKILL IN THE ART

The level of ordinary skill in the art may be reflected by the prior art of record. *See Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001). Here, a

Person of Ordinary Skill in the Art ("POSITA") at the time of the claimed invention would have a bachelor's degree or the equivalent degree in electrical and/or computer engineering, physics, optical sciences or a related field and 2-3 years of experience in imaging systems including optics and image processing. (APPL-1003), Sasián, ¶20. Furthermore, a person with less formal education but more experience, or more formal education but less experience, could have also met the relevant standard for a POSITA. *Id.* However, Petitioner does not imply that a person having an extraordinary level of skill should be regarded as a POSITA.

VI. CLAIM CONSTRUCTION

The challenged claims of the '408 Patent are construed herein "using the same claim construction standard that would be used to construe the claim in a civil action under 35 U.S.C. §282(b)." 37 C.F.R. §42.100(b) (Nov. 13, 2018). The claim terms construed below are thus construed "in accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent." *Id.* For terms not addressed below, Petitioner submits that no specific construction is necessary for this proceeding.

A. **"s*mooth transition*" (claim 6)**

In the context of the '408 Patent, a POSITA would have understood that "*smooth transition*" to mean ""transition with a reduced discontinuous image change," for example, a transition with a continuous image change. (APPL-1003), Sasián, ¶¶44-47.

The specification of the '408 Patent supports the proposed construction. (APPL-1003), Sasián, ¶45. Regarding the term "smooth transition" under "Video Mode Operation/Function," the '408 Patent provides,

> Smooth Transition
>
> **When a dual-aperture camera switches the camera output between sub-cameras or points of view, a user will normally see a "jump" (discontinuous) image change.** However, a change in the zoom factor for the same camera and POV is viewed as a **continuous change**. **A "smooth transition" is a transition between cameras or POVs that minimizes the jump effect.**

(APPL-1001), '408 Patent, 10:35-43. As such, the '408 Patent defines the term "jump" to mean "discontinuous" image change, and defines a "smooth transition" to be a transition that minimizes the "discontinuous" image change. (APPL-1003), Sasián, ¶45. Furthermore, the '408 Patent provides that "smooth transition" includes at least a transition with "a continuous change." *Id.*

The '408 Patent provides examples of techniques that may be used to achieve smooth transition:

This **<u>may</u>** include matching the position, scale, brightness and color of the

> output image before and after the transition. However, an entire image position matching between the sub-camera outputs is **in many cases** impossible, because parallax causes the position shift to be dependent on the object distance. Therefore, in **a smooth transition** as disclosed herein, the position matching is achieved only in the ROI region while scale brightness and color are matched for the entire output image area.

(APPL-1001), '408 Patent, 10:43-51; (APPL-1003), Sasián, ¶46. A POSITA would have understood that these descriptions are merely examples for achieving smooth transition, and therefore are not definitions for smooth transition. *Id.*

Accordingly, in the context of the '408 Patent, a POSITA would have understood "*smooth transition*" to mean "“transition with a reduced discontinuous image change," for example, a transition with a continuous image change. (APPL-1003), Sasián, ¶47.

VII. REQUESTED RELIEF

Petitioner requests that the Board institute *inter partes* review of claims 5-6 of the '408 Patent and cancel each of those claims as unpatentable.

VIII. OVERVIEW OF CHALLENGES

A. Challenged Claims

Claims 5-6 of the '408 Patent are challenged.

B. Statutory Grounds for Challenges

Ground No.	Claims	Basis
1	5-6	Obvious under post-AIA §103 over Golan and Kawamura

Golan was published February 2, 2012. Kawamura was published September 14, 2006 and issued December 20, 2011. Golan and Kawamura are prior art to the ’408 Patent under at least post-AIA 35 U.S.C. §102(a)(1), and are not subject to an exception under §102(b)(1).

C. Discretionary Denial is Not Warranted

The Board should not exercise its discretion under 35 U.S.C. §§ 314(a) or 325(d) to deny this Petition. Among other factors, none of the asserted prior art was cited during examination, and there is no "overlap between the arguments made during examination and the manner in which Petitioner relies on the prior art." *Becton, Dickinson and Company v. B. Braun Melsungen AG*, IPR2017-01586, Paper 8 at 17–18 (PTAB Dec. 15, 2017) (precedential). Further, the ’408 Patent has not been challenged in any prior IPR petition. None of discretionary institution factors 1–5 in *General Plastic* apply to this Petition. *See General Plastic Indus. Co., Ltd. v. Canon Kabushiki Kaisha*, IPR2016-01357, Paper 19 at 16 (PTAB Sept. 6, 2016) (Section II.B.4.i. precedential).

D. Page Citations and Emphasis

For exhibits that include suitable page, column, or paragraph numbers in their original publication, Petitioner's citations are to those original numbers and not to the page numbers added for compliance with 37 CFR 42.63(d)(2)(ii). The

Petition may bold or italicize quotations and add color or colored annotations to figures from exhibits for emphasis.

IX. IDENTIFICATION OF HOW THE CLAIMS ARE UNPATENTABLE

A. Ground 1: Claims 5-6 are unpatentable under 35 U.S.C. § 103 over Golan and Kawamura

1. Summary of Golan

U.S. Patent Application Publication No. 2012/0026366 to Golan et al. ("Golan") was published on February 2, 2012. Golan is titled "Continuous Electronic Zoom for an Imaging System with Multiple Imaging Devices Having Different Fixed FOV," and discloses providing a video output with "a continuous electronic zoom for an image acquisition system, the system including multiple imaging devices having different fixed FOV." (APPL-1005), Golan, FIG. 1, Title, [0002]; (APPL-1003), Sasián, ¶¶49-52.

Golan teaches use of wide and tele lenses and employs wide and tele images during digital zooming, which "facilitates a light weight electronic zoom with a large lossless zooming range." (APPL-1005), Golan, [0009]. Specifically, as illustrated in FIG. 1 below, Golan discloses zoom control sub-system 100 for an image acquisition system including "multiple image sensors, each with a fixed and preferably different FOV." (APPL-1005), Golan, [0036]. Golan's zoom control subsystem 100 includes a tele image sensor 110 coupled with a narrow lens 120 having a tele FOV 140, a wide image sensor 112 coupled with a wide lens 122 having a wide FOV 142, a zoom

control module 130 and an image sensor selector 150. (APPL-1005), Golan, FIG. 1, [0037].

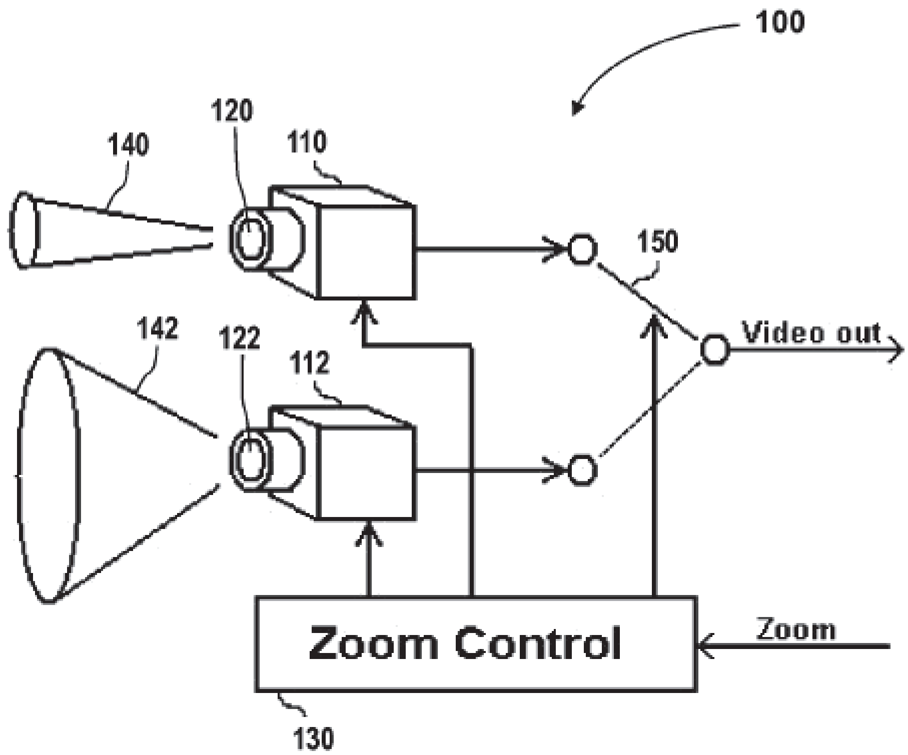


Fig 1

(APPL-1005), Golan, FIG. 1

Golan teaches that, in embodiments of FIGS. 1 and 2, each image frame of video output is generated based on an acquired image frame from "the relevant image sensor" of an image acquisition device selected based on the user input zoom factor. (APPL-1005), Golan, FIGS. 1-2, [0039]. Specifically, Golan teaches that a zoom control circuit 130 that receives a required zoom from an operator of the image

acquisition system and selects the relevant image sensor (110 or 112) by activating image sensor selector 150 position. (APPL-1005), Golan, [0039].

Golan teaches that "alignment between the wide image sensor array and the tele image sensor array is computed, to facilitate **continuous electronic zoom with uninterrupted imaging, when switching back and forth between the wide image sensor array and the tele image sensor array**." (APPL-1005), Golan, Abstract. Specifically, Golan describes that "an electronic[] calibrati[on] is performed to determine the alignment offsets between wide image sensor array 110 and tele image sensor array 112," (APPL-1005), Golan, [0038], and that the "calibration of the alignment, between the first image sensor array and the second image sensor array, **facilitates continuous electronic zoom with uninterrupted imaging**, when **switching** back and forth between the first image sensor array and the second image sensor array." (APPL-1005), Golan, [0015]. The electronic calibration is performed preferably with sub-pixel accuracy. *Id.*

2. Summary of Kawamura

Kawamura is titled "Telephoto Lens," and describes a "telephoto lens of a four-group, five-lens configuration." (APPL-1007), Kawamura, Title, Scope of Patent Claim. (APPL-1003), Sasián, ¶¶53-59.

Specifically, Kawamura's telephoto lens system is designed to "provide a lens that keeps a compactness of an overall length to a conventional level of a

telephoto ratio of about 0.96 to 0.88," "has an excellent image-formation performance due to favorably correcting spherical aberration of both a reference wavelength and color," and also with "decreasing chromatic aberration in magnification." (APPL-1007), Kawamura, 1.

Kawamura offers a number of examples (examples 1-4) that each include five lens elements. (APPL-1007), Kawamura, 1, FIGS. 1, 3, 6, 8. In each embodiment, the telephoto lens system includes a four-group, five-lens configuration including:

> in order from an object side, a first lens, which is a positive meniscus lens that is convex toward the object side; a second lens and a third lens, which are a laminated positive meniscus lens of a negative meniscus lens and positive meniscus lens having a lamination surface that is convex toward the object side; a fourth lens, which is a negative lens having a rear surface with a large curvature that is concave toward an image-surface side; and a fifth lens, which is a positive lens.

(APPL-1007), Kawamura, 1.

To achieve the object of keeping a compactness while having an excellent image-formation performance, Kawamura teaches that each embodiment satisfies following conditions (1) to (8):

(1) $0.3F < F_{1\cdot2\cdot3} < 0.5F$

(2) $1.0F < F_{1\cdot2\cdot3\cdot4} < 2.5F$

(3) $0.1F < d_1 + d_2 + d_3 + d_4 + d_5 + d_6 < 0.2F$

(4) $0.1F < d_7 < 0.3F$

(5) $30 < \nu_4 < 50$

(6) $0.1F < r_4 < 0.25F$

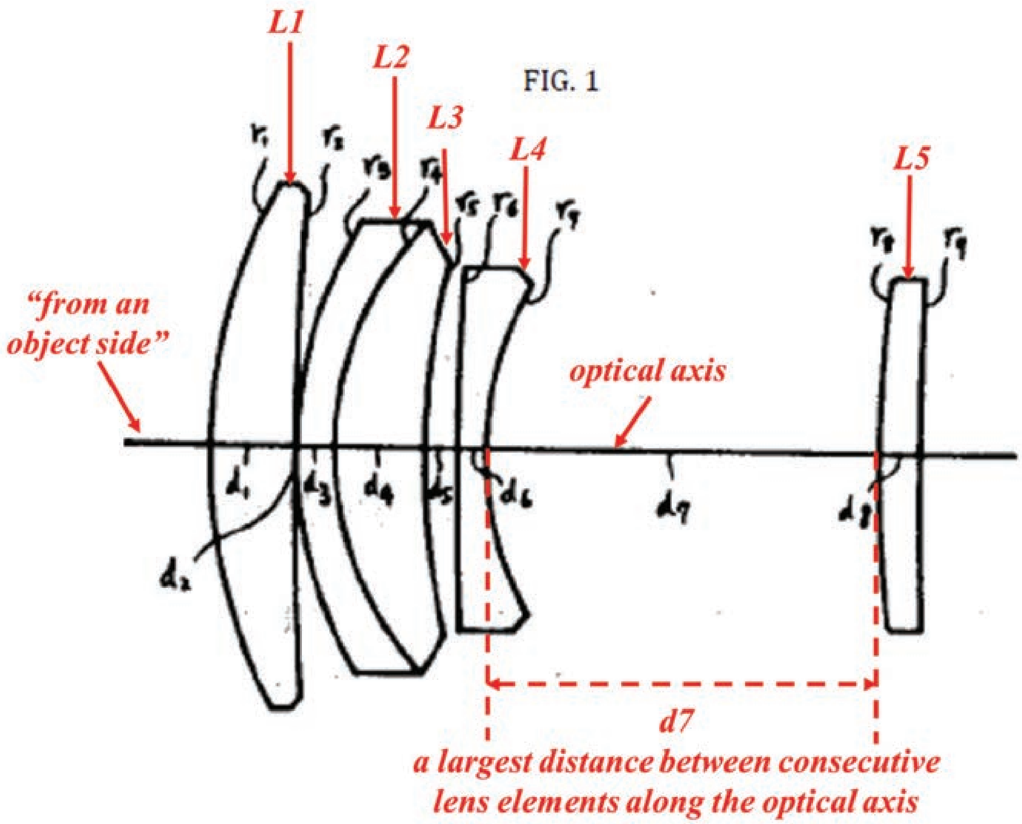
(7) $0.05 < n_2 - n_3 < 0.3$

(8) $5 < \nu_3 - \nu_2 < 50$

(APPL-1007), Kawamura, 1.

Kawamura describes each of the eight conditions in detail. (APPL-1007), Kawamura, 2-3. For example, Kawamura explains, "[c]ondition (1) is a condition that, in connection with conditions (2) and (3), indicates an allocation of a focal length necessary to set a telephoto ratio to about 0.96 to 0.88 and form a framework of the telephoto lens that favorably corrects aberration." (APPL-1007), Kawamura, 2. Kawamura further explains that condition (4) relating to d7 (a distance between lens elements 4 and 5) "is a condition relating to a position of the fifth lens. If d7 is greater than the upper limit, a diameter of the fifth lens is too large to maintain an appropriate peripheral light amount, which is not preferable in terms of frame configuration. Moreover, if d7 is smaller than the lower limit, coma aberration arises, which is not preferable due to correction thereof being difficult." (APPL-1007), Kawamura, 2.

For each of the examples 1-4, Kawamura provides figures and a prescription table including numerical values for the design. (APPL-1003), Sasián, ¶58. As an example, FIG. 1 and corresponding table of example 1 are reproduced below:



(APPL-1007), Kawamura, FIG. 1, annotated

Example 1

1 : 4.1 F = 200.079 ω = 12.3°.

NO.	r	d	N	ν
1	57.091	9.00	1.60311	60.7
2	330.000	0.20		
3	45.039	4.00	1.67270	32.1
4	33.450	9.60	1.48749	70.1
5	81.000	3.50		
6	387.380	3.00	1.57501	41.5
7	34.361	$\boxed{41.80}$		
8	146.228	4.34	1.74950	35.3
9	552.040			

d7
a largest distance between consecutive lens elements along the optical axis

$F_{1 \cdot 2 \cdot 3} = 74.912$

$F_{1 \cdot 2 \cdot 3 \cdot 4} = 356.466$

$d_1 + d_2 + d_3 + d_4 + d_5 + d_6 = 29.3$

(APPL-1007), Kawamura, 2, Prescription Table for Example 1, annotated

As shown in the annotated FIG. 1 and prescription table of example 1 of Kawamura above, the telephoto lens configuration of Kawamura includes five lens elements annotated as L1 through L5, and a largest distance between consecutive lens elements along the optical axis is a distance d7 between the fourth lens element and the fifth lens element. (APPL-1003), Sasián, ¶58.

3. Reasons to Combine Golan and Kawamura

A POSITA would have been motivated to apply Kawamura's teachings of a telephoto lens including five lens elements in the digital camera of Golan to produce the obvious, beneficial, and predictable results of a digital camera including a tele lens with a compactness of an overall length while having an excellent image-formation performance as taught by Kawamura. (APPL-1003), Sasián, ¶¶60-64. Because Golan does not provide specific lens prescriptions, a POSITA would have had the need of using a tele lens. *Id.*, ¶60. Furthermore, a POSITA would have been motivated to apply Kawamura's teachings of tele lens because of the imaging benefits and compactness of an overall length with excellent image-formation performance as taught by Kawamura. *Id.*

First, the references are analogous prior art and are in the same field of endeavor pertaining to imaging systems including a telephoto lens. *Id.*, ¶61. Golan discloses providing video output images using a computerized image acquisition system "having a wide image acquisition device and **a tele image acquisition device having a tele image sensor array coupled with a tele lens** having a narrow FOV, and a tele electronic zoom." (APPL-1005), Golan, Abstract. Similarly, Kawamura is titled "Telephoto Lens" and discusses a "**telephoto lens**" with "a compactness of an overall length" and "excellent image-formation performance." (APPL-1007), Kawamura, 1. Accordingly, both Golan

and Kawamura disclose imaging systems including a telephoto lens. (APPL-1003), Sasián, ¶61.

Second, a POSITA would have been motivated to incorporate the teachings of Golan and Kawamura because they share a need to provide a compact and light weight imaging system while providing excellent image quantity. *Id.*, ¶62. Golan recognizes that a typical camera with a large dynamic zoom range "requires heavy and expensive lenses, as well as complex design," and has a goal to provide an imaging device with "light weight" electronic zoom. (APPL-1005), Golan, [0007]-[0008]. As such, Golan provides an explicit motivation to use a compact lens design, including a compact telephoto lens design. (APPL-1003), Sasián, ¶62. Furthermore, Golan recognizes the need to provide excellent image quality by providing "lossless electronic zoom" for maintaining the desired resolution and by providing "continuous electronic zoom with uninterrupted imaging." (APPL-1005), Golan, Abstract, [0004]; (APPL-1003), Sasián, ¶62. Similar to Golan, an objective of Kawamura is to provide a telephoto lens that "keeps a **compactness of an overall length** to a conventional level of a telephoto ratio of about 0.96 to 0.88 but has **an excellent image-formation performance**." (APPL-1007), Kawamura, 1; (APPL-1003), Sasián, ¶62. Furthermore, a POSITA would have recognized that Kawamura's telephoto lens provides additional benefits, including for example, a relatively large field of view and little vignetting. (APPL-1003), Sasián, ¶62.

Here, providing a compact and light weight imaging system with excellent image performance is a need or a goal shared by Golan and Kawamura, and provides at least one reason to combine the respective teachings. (APPL-1003), Sasián, ¶62.

Third, combining the teachings of Kawamura with the system of Golan would have produced operable results that are predictable. (APPL-1003), Sasián, ¶63. Specifically, combining Kawamura's teachings of telephoto lens design in the digital camera of Golan would have been no more than the combination of known elements according to known methods (such as modifying the tele lens 120 in zoom control subsystem of Golan according to Kawamura's teachings), and would have been obvious to a POSITA at the time of the '408 Patent to achieve the benefits of a compact imaging system with excellent image performance described by Kawamura. *Id.* Petitioner's combination of Kawamura's teaching with the digital camera of Golan does not require physical incorporation of Kawamura's telephoto lens into the digital camera of Golan. *Id.*

To the extent that modifications would have been needed in order to accommodate the teachings of Kawamura in the system of Golan, such modifications would have been within the level of ordinary skill in the art. *Id.*, ¶64. For example, while Kawamura describes that its invention "relates to a medium telephoto lens of a brightness of about 1:4 and is applied as, for example, a lens of a focal length of about 200 mm for a screen size of 6×7 or a focal length

of about 150 mm for a screen size of 4.5×6," modifications or adjustments would have been within the level of ordinary skill in the art. *Id.* For example, lens scaling was a well-known practice in lens design, and a POSITA would have scaled the Kawamura lens prescriptions to fit into a digital camera of Golan while maintaining the compactness and an excellent image-formation performance. *Id.; see, e.g.*, (APPL-1006), Smith, 57 ("A lens prescription can be scaled to any desired focal length simply by multiplying all of its dimensions by the same constants. All of the linear aberration measures will then be scaled by the same factor."); (APPL-1009), ZEMAX User's Manual, 254-355 (describing performing scaling using ZEMAX).

4. Claim 5

[5.0] ***A zoom digital camera comprising:***

To the extent that this preamble is deemed limiting, Golan teaches a zoom digital camera. (APPL-1003), Sasián, ¶¶65-69.

Specifically, Golan is titled "**Continuous Electronic Zoom for an Imaging System with Multiple Imaging Devices** Having Different Fixed FOV," and teaches a zoom digital imaging system with multiple imaging devices each defining an aperture for capturing a digital image. (APPL-1005), Golan, Title. Golan explains that "**digital zoom** is a method of narrowing the apparent angle of view of **a digital still or video image**," and that "[u]sing two (or more) image

sensors, having different fixed FOV, facilitates **a light weight electronic zoom with a large lossless zooming range**." (APPL-1005), Golan, [0003], [0009].

As shown in Fig. 1 of Golan below, Golan's image acquisition system includes a zoom control sub-system 100, which includes "a tele image sensor 110 coupled with a narrow lens 120 having a predesigned FOV 140, a wide image sensor 112 coupled with a wide lens 122 having a predesigned FOV 142, **a zoom control module 130** and an image sensor selector 150." (APPL-1005), Golan, [0037]. Golan's zoom control circuit 130 "receives a required zoom from an operator of the image acquisition system and selects the relevant image sensor (110 and 112) by activating image sensor selector 150 position. The relevant camera zoom factor is calculated by zoom control unit 130." (APPL-1005), Golan, [0039].

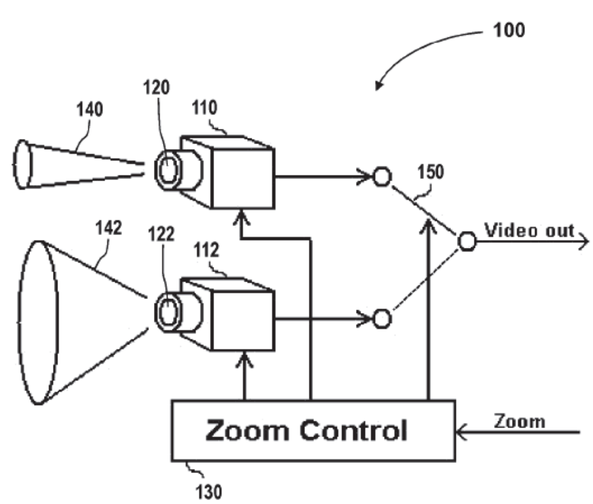


Fig 1

(APPL-1005), Golan, FIG. 1

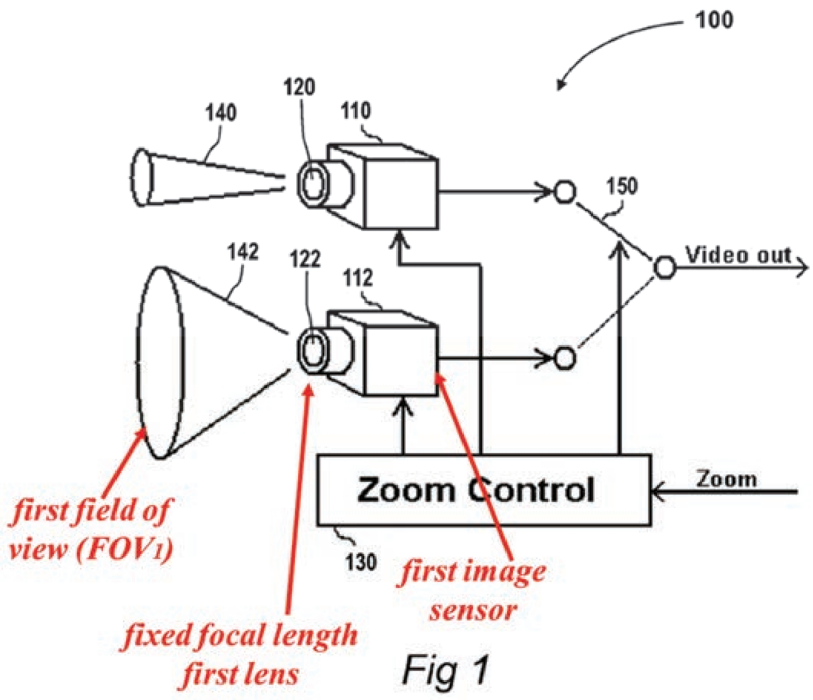
In Golan's zoom control sub-system 100, each of the Wide imaging device (including wide image sensor 112 and wide lens 122) and the Tele imaging device (including tele image sensor 110 and narrow lens 120) defines an aperture for generating a corresponding digital image. (APPL-1003), Sasián, ¶68. As such, Golan's image acquisition system including a zoom control sub-system 100 is a digital camera providing digital zoom, therefore, teaches a zoom digital camera. *Id.*

Therefore, Golan's image acquisition system including zoom control sub-system 100 teaches "*[a] zoom digital camera*," as recited in the claim. *Id.*, ¶69.

[5.1] ***a) a first imaging section that includes a fixed focal length first lens with a first field of view (FOV_1) and a first image sensor; and***

Golan teaches a first imaging section that includes a fixed focal length first lens with a first field of view (FOV_1) and a first image sensor. (APPL-1003), Sasián, ¶¶70-78.

First, as shown in annotated Fig. 1 of Golan below, Golan's zoom control sub-system 100 includes a first imaging section that includes a wide lens 122 (first lens) with a FOV 142 (a first field of view (FOV_1)) and a wide image sensor 112 (first image sensor). (APPL-1005), Golan, Fig. 1, [0036]-[0037].



(APPL-1005), Golan, FIG. 1, annotated

Second, because Golan's wide lens 122 has "a **predesigned** FOV 142," it teaches a fixed focal length first lens. (APPL-1003), Sasián, ¶72; (APPL-1005), Golan, [0037]; *see also* (APPL-1005), Golan, [0009] ("[u]sing two (or more) image sensors, having different **fixed FOV**, facilitates a light weight electronic zoom with a large lossless zooming range"), [0036] ("Zoom control sub-system 100 includes multiple image sensors, each with a **fixed** and preferably different **FOV**, configured to provide continuous electronic zoom capabilities with uninterrupted, when switching back and forth between the image sensors."); [0043] ("Both image acquisition devices (110 and 112) include an image sensor array

coupled with a lens (120 and 122, respectively), providing a **fixed FOV (tele FOV 140 and wide FOV 142, respectively)**.”).

A POSITA would have understood that because wide lens 122 has a FOV 142 that is fixed and has a predesigned value, the wide lens 122 has a fixed focal length. (APPL-1003), Sasián, ¶73.

In a digital camera, the focal length of a lens determines the angle of FOV relative to a given sensor format, and as such, an FOV angle may be computed based on the focal length f of the lens and the diagonal (K) of the sensor. (APPL-1016), Jacobson, 48; (APPL-1003), Sasián, ¶73. For example, as shown in the imaging system of Figure 4.13 of Jacobson, the angle of FOV is the angle subtended at the lens by the diagonal (K) of the sensor when the lens is focused on infinity. *Id.* For a given sensor diagonal size K, a lens having a fixed FOV has a fixed focal length.

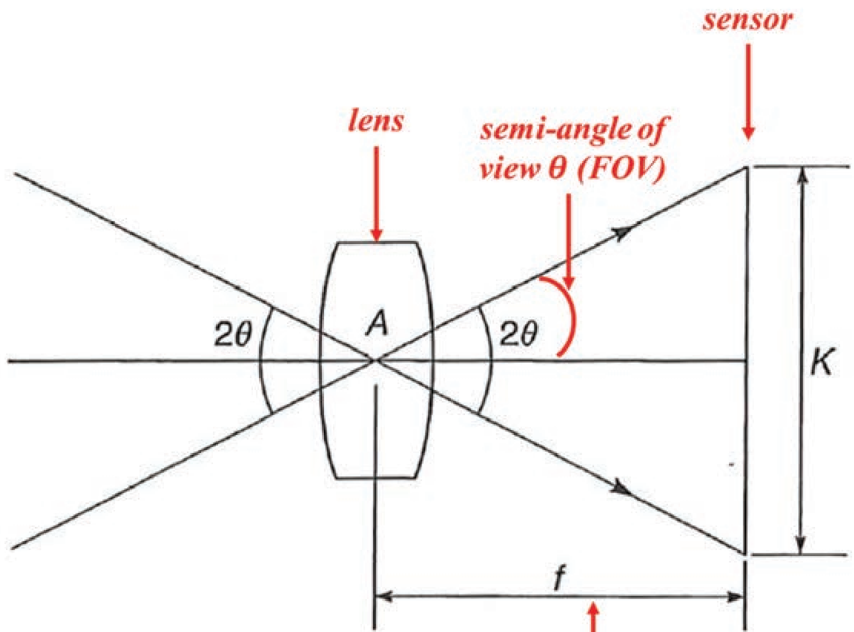


Figure 4.13 Field (angle) of view (FOV) of a lens related to format dimension

(APPL-1016), Jacobson, FIG. 4.13, annotated

A POSITA would have understood that normally an angle of FOV is defined as "the angle subtended at the lens by the diagonal (K) of the sensor when the lens is focused on infinity." (APPL-1016), Jacobson, 48; (APPL-1003), Sasián, ¶75. For example, as shown in the imaging system of FIG. 4.13 of Jacobson, the FOV angle A is twice the semi-angle of view θ, and the focal length f of a lens determines the FOV angle A relative to a given sensor format as follows:

$$A = 2\theta = 2\tan^{-1}\left(\frac{K}{2f}\right), \qquad (1)$$

Id.

The FOV in the ’408 Patent is defined as “measured from the center axis to the corner of the sensor (i.e. half the angle of the normal definition).” (APPL-1001), ’408 Patent, 7:7-9. As such, a POSITA would have understood that the FOV in the ’408 Patent corresponds to the semi-angle of view θ of Fig. 4.13 of Jacobson calculated as:

$$\text{FOV (as defined in '408 Patent)} = \theta = \tan^{-1}\left(\frac{K}{2f}\right). \tag{2}$$

(APPL-1003), Sasián, ¶76. While the analysis below is based on FOV as defined in the ’408 Patent (half the angle of the normal definition), the analysis is the same for using FOV as defined in Jacobson. *Id.*

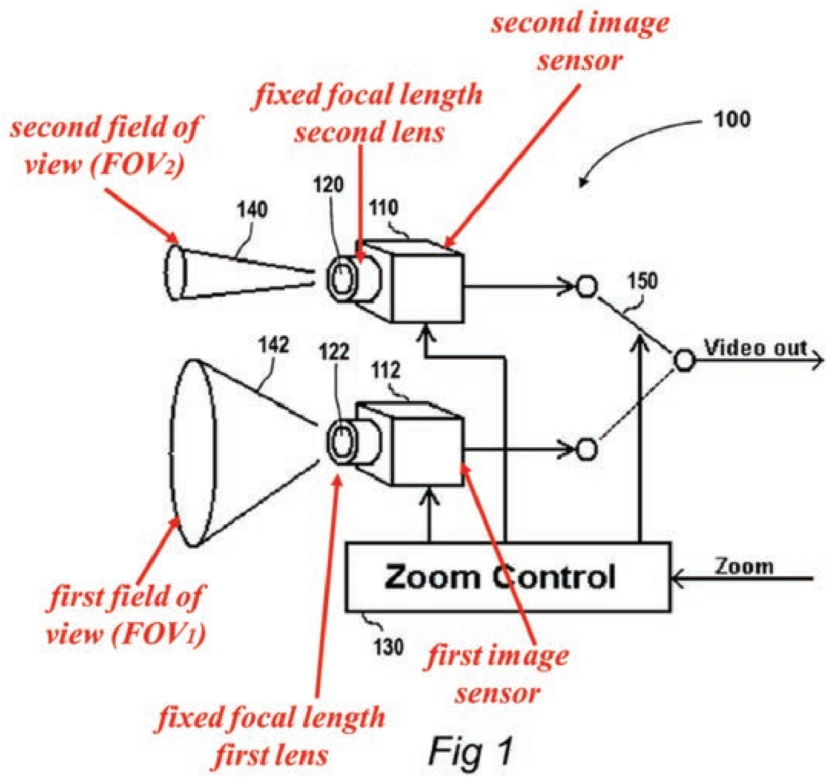
Because Golan’s wide lens 122 of the first imaging section has a fixed FOV 142, it has a fixed focal length. Thus, Golan teaches a first imaging section with a fixed focal length first lens. (APPL-1003), Sasián, ¶77.

Therefore, Golan’s zoom control sub-system 100 includes a first imaging section that includes a fixed focal length wide lens 122 with a fixed FOV 142 and a wide image sensor 112, which teaches “*a first imaging section that includes a fixed focal length first lens with a first field of view (*FOV_1*) and a first image sensor*” as recited in the claim. (APPL-1003), Sasián, ¶78.

[5.2] ***b) a second imaging section that includes a fixed focal length second lens with a second FOV (FOV_2) that is narrower than $FOV_{[1]}$, and a second image sensor,***

Golan teaches a second imaging section that includes a fixed focal length second lens with a second FOV (FOV_2) that is narrower than $FOV_{[1]}$, and a second image sensor. (APPL-1003), Sasián, ¶¶79-82.

First, as shown in annotated Fig. 1 of Golan below, Golan's zoom control sub-system 100 includes a second imaging section that includes a tele image sensor 110 (second sensor) coupled with a narrow lens 120 (a fixed focal length second lens) having a predesigned FOV 140 (second FOV (FOV_2)). APPL-1003), Sasián, ¶79; (APPL-1005), Golan, Fig. 1, [0036]-[0037]; *see also* (APPL-1005), Golan, Abstract ("a computerized image acquisition system [] having … a tele image acquisition device having a tele image sensor array coupled with a tele lens having a narrow FOV.").



(APPL-1005), Golan, FIG. 1, annotated

Second, for the same reason discussed in [1.1], because Golan's tele lens 120 has "a **predesigned** FOV 140," it teaches a fixed focal length second lens. (APPL-1005), Golan, [0037]; *see also* (APPL-1005), Golan, [0009], [0036], [0043]. As such, Golan teaches a second imaging section including a fixed focal length second lens. (APPL-1003), Sasián, ¶80.

Third, Golan teaches a FOV 140 (FOV_2) of the narrow lens 120 that is narrower than FOV 142 (FOV_1) of the wide lens 122. (APPL-1003), Sasián, ¶81. Specifically, Golan provides that "[p]referably, wide FOV 142 is **substantially wider than** narrow FOV 140." (APPL-1005), Golan, [0043]. In other words,

Golan teaches that narrow FOV 140 (FOV_2) is narrower than wide FOV 142 (FOV_1). (APPL-1003), Sasián, ¶81; *see also* (APPL-1005), Golan, Fig. 1, [0009], [0037] (providing that "[i]n the optimal configuration, the FOV of wide image sensor 112 can be calculated by multiplying the FOV of tele image sensor 110 by the optimal zoom of image sensors 110 and 112," where the optimal zoom is greater than one).

Therefore, Golan's zoom control sub-system 100 includes a second imaging section that includes a tele image sensor 110 and a fixed focal tele lens 120 with fixed tele FOV 140 narrower than fixed wide FOV 142, which teaches "*a second imaging section that includes a fixed focal length second lens with a second FOV (FOV_2) that is narrower than $FOV_{[1]}$, and a second image sensor*" as recited in the claim. (APPL-1003), Sasián, ¶82.

[5.3] ***wherein the second lens includes five lens elements along an optical axis starting from an object starting with a first lens element with positive power, wherein the five lens elements further include a second lens element with negative power, a fourth lens element with negative power and a fifth lens element,***

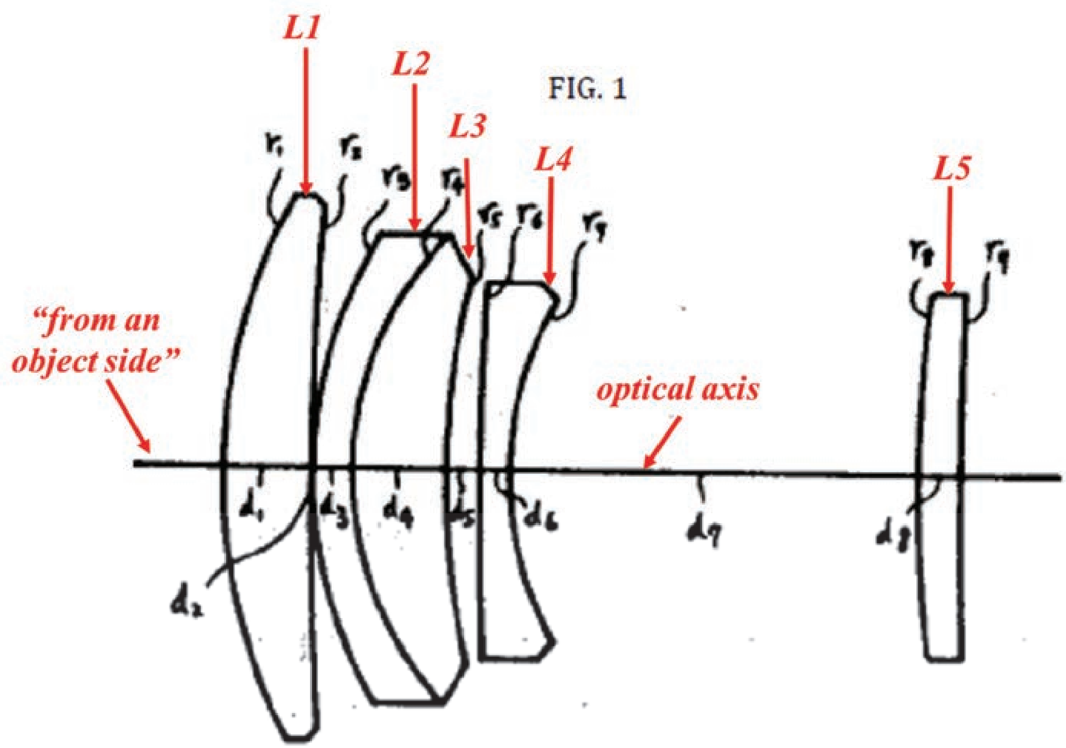
Golan in view of Kawamura renders obvious that the second lens includes five lens elements along an optical axis starting from an object starting with a first lens element with positive power, wherein the five lens elements further include a

second lens element with negative power, a fourth lens element with negative power and a fifth lens element. (APPL-1003), Sasián, ¶¶83-92.

First, each of example 1 of FIGS. 1-2, example 2 of FIGS. 3-4, example 3 of FIGS. 5-6, and example 4 of FIGS. 7-8 of Kawamura teaches a fixed focal length tele lens that includes five lens elements along an optical axis starting from an object starting with a first lens element with positive power, wherein the five lens elements further include a second lens element with negative power, a fourth lens element with negative power and a fifth lens element. (APPL-1003), Sasián, ¶84. While the analysis below uses example 1 as an example, similar analysis applies to examples 2-4 of Kawamura. *Id.*

Specifically, as shown in annotated FIG. 1 of Kawamura below, Kawamura teaches a lens system referred to as example 1 including five lens elements, (annotated as L1 through L5) along an optical axis starting from an object. (APPL-1007), Kawamura, FIG. 1, 1, 5; (APPL-1003), Sasián, ¶85. Kawamura describes that a "telephoto lens of a four-group, **five-lens configuration**" that includes, "**in order from an object side**, a **first** lens, which is a **positive** meniscus lens that is convex toward the object side; a **second** lens and a **third** lens, which are a laminated positive meniscus lens of **a negative meniscus lens** and **positive meniscus lens** having a lamination surface that is convex toward the object side; a **fourth lens, which is a negative lens** having a rear surface with a large curvature that is concave toward an

image-surface side; and a fifth lens, which is a positive lens." (APPL-1007), Kawamura, 1. A POSITA would have understood that Kawamura's telephoto lens includes a doublet made up of two simple lenses L2 (Kawamura's second lens) and L3 (Kawamura's third lens) paired together (e.g., cemented together). (APPL-1003), Sasián, ¶85.



(APPL-1007), Kawamura, FIG. 1, annotated

Kawamura's first lens L1 of example 1, which is the first of lenses L1 through L5 along an optical axis starting from an object, teaches "*a first lens element with positive power*" as claimed. (APPL-1003), Sasián, ¶86. Specifically, Kawamura explains that its telephoto lens includes "in order **from an object side**, a **first** lens, which is a **positive** meniscus lens that is convex toward the object side," and

therefore, teaches a first lens element L1 with positive power. (APPL-1007), Kawamura, 1.

Kawamura's second lens L2 of example 1, which is the second lens of lenses L1 through L5 along the optical axis starting from an object, teaches "*a second lens element with negative power*" as claimed. (APPL-1003), Sasián, ¶87. Specifically, Kawamura explains that its telephoto lens includes "in order **from an object side**, … a **second** lens and a third lens, which are a laminated positive meniscus lens of a **negative** meniscus lens and **positive** meniscus lens having a lamination surface that is convex toward the object side." (APPL-1007), Kawamura, 1. As such, a POSITA would have understood that example 1 of Kawamura teaches that second lens L2 is "a **negative** meniscus lens" with negative power, third lens L3 is a "**positive** meniscus lens" with positive power, and lens elements L2 and L3 are combined to form "a laminated positive meniscus lens." (APPL-1007), Kawamura, 1; (APPL-1003), Sasián, ¶87.

Kawamura's fourth lens L4 of example 1, which is the fourth lens of lenses L1 through L5 along the optical axis starting from an object, teaches "*a fourth lens element with negative power*" as claimed. (APPL-1003), Sasián, ¶88. Specifically, Kawamura explains that its telephoto lens includes "in order from an object side, … a **fourth** lens, which is a **negative** lens having a rear surface with a large curvature

that is concave toward an image-surface side," and therefore teaches a fourth lens element with negative power. *Id.*; (APPL-1007), Kawamura, 1.

Kawamura's fifth lens L5 of example 1, which is the fifth lens of lenses L1 through L5 along the optical axis starting from an object, teaches "*a fifth lens element*" as claimed. (APPL-1003), Sasián, ¶89. Specifically, Kawamura explains that fifth lens L5 "is a positive lens," and therefore has positive power. *Id.*; (APPL-1007), Kawamura, 1.

Similar to the analysis of example 1 of Kawamura, as illustrated in FIGS. 3, 5, and 7 of Kawamura and corresponding tables of corresponding lens data respectively, each of examples 2-4 of Kawamura includes five lens elements along an optical axis starting from an object starting with a first lens element with positive power, wherein the five lens elements further include a second lens element with negative power, a fourth lens element with negative power and a fifth lens element. (APPL-1007), Kawamura, FIGS. 3, 5, and 7, 1-5; (APPL-1003), Sasián, ¶90.

A POSITA would have been motivated to apply Kawamura's teachings of a telephoto lens with the five lens elements configuration in the fixed focal length tele lens 120 of the digital camera of Golan, to achieve the benefit of "a compactness of an overall length to a conventional level of a telephoto ratio of about 0.96 to 0.88," "an excellent image-formation performance due to favorably correcting spherical aberration of both a reference wavelength and color" with

"decreasing chromatic aberration in magnification." (APPL-1007), Kawamura, 1; (APPL-1003), Sasián, ¶91. *See also* Ground 1: Reasons to Combine Golan and Kawamura.

Accordingly, in the zoom digital camera of Golan and Kawamura, a zoom control subsystem 100 includes a tele lens 120 having a five lens element configuration as taught by Kawamura, which renders obvious that "*the second lens includes five lens elements along an optical axis starting from an object starting with a first lens element with positive power, wherein the five lens elements further include a second lens element with negative power, a fourth lens element with negative power and a fifth lens element*" as claimed. (APPL-1003), Sasián, ¶92.

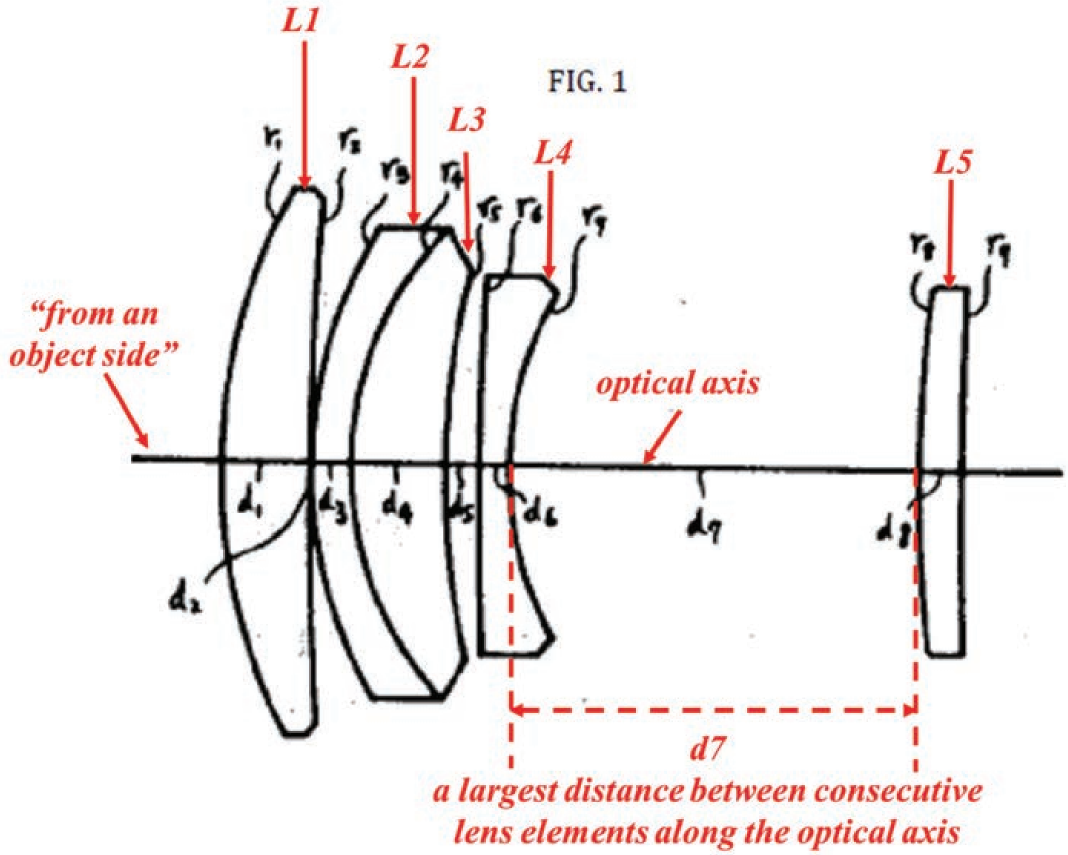
[5.4] ***wherein a largest distance between consecutive lens elements along the optical axis is a distance between the fourth lens element and the fifth lens element, and***

Golan in view of Kawamura renders obvious that a largest distance between consecutive lens elements along the optical axis is a distance between the fourth lens element and the fifth lens element. (APPL-1003), Sasián, ¶¶93-99.

First, as discussed in [5.3], in combination of Golan and Kawamura, the digital camera includes a telephoto lens including five lens elements as taught by Kawamura. (APPL-1003), Sasián, ¶94.

Second, Kawamura teaches that, in its telephoto lens, a largest distance between consecutive lens elements along the optical axis is a distance between the fourth lens element and the fifth lens element. (APPL-1003), Sasián, ¶95.

Specifically, as shown in annotated FIG. 1 of Kawamura below, in Kawamura's lens system example 1, distance d2 is between consecutive lens elements L1 and L2. (APPL-1003), Sasián, ¶96. Because lens elements L2 and L3 are combined to form a composite lens, the distance between lens elements L2 and L3 is close to zero. *Id.* Further, distance d5 is a distance between the third lens element L3 and the fourth lens element L4, and d7 is a distance between the fourth lens element L4 and the fifth lens element L5. *Id.*



(APPL-1007), Kawamura, FIG. 1, annotated

As shown in annotated FIG. 1 of Kawamura, distance d7 between fourth and fifth lens elements L4 and L5 is the largest distance between consecutive lens elements along the optical axis, among distance d2, a distance close to 0, distance d5, and distance d7. (APPL-1003), Sasián, ¶97. This is confirmed by the annotated Example 1 table of Kawamura below, where distance d7 has a value of "41.80," which is the largest distance between consecutive lens elements along the optical axis among distance d2 ("0.20"), distance d5 ("3.50"), and distance d7 ("41.80"). *Id.*

1 : 4.1 F = 200.079 ω = 12.3°

NO.	r	d	N	ν
1	57.091	9.00	1.60311	60.7
2	330.000	0.20		
3	45.039	4.00	1.67270	32.1
4	33.450	9.60	1.48749	70.1
5	81.000	3.50		
6	387.380	3.00	1.57501	41.5
7	34.361	$\boxed{41.80}$		
8	146.228	4.34	1.74950	35.3
9	552.040			

a largest distance between consecutive lens elements along the optical axis d7

$$F_{1\cdot2\cdot3} = 74.912$$

$$F_{1\cdot2\cdot3\cdot4} = 356.466$$

$$d_1 + d_2 + d_3 + d_4 + d_5 + d_6 = 29.3$$

(APPL-1007), Kawamura, 3, table for example 1, annotated

Similar to the analysis of example 1 of Kawamura, in each of examples 2-4 of Kawamura, distance d7 between fourth and fifth lens elements L4 and L5 is the largest distance between consecutive lens elements along the optical axis. (APPL-1003), Sasián, ¶98. Such a largest distance between consecutive lens elements along the optical axis remains a largest distance after scaling. *Id.*

Accordingly, in the zoom digital camera of Golan and Kawamura, a zoom control subsystem 100 includes a tele lens 120 having a five lens element configuration as taught by Kawamura, where distance d7 between fourth and fifth

lens elements L4 and L5 is the largest distance between consecutive lens elements along the optical axis, which renders obvious that "*a largest distance between consecutive lens elements along the optical axis is a distance between the fourth lens element and the fifth lens element*" as claimed. (APPL-1003), Sasián, ¶99.

[5.5] ***wherein a ratio of a total track length (TTL) to effective focal length (EFL) of the second lens is smaller than 1.***

Golan in view of Kawamura renders obvious that a ratio of a total track length (TTL) to effective focal length (EFL) of the second lens is smaller than 1. (APPL-1003), Sasián, ¶¶100-107.

First, as discussed in [5.3], in combination of Golan and Kawamura, the digital camera includes a telephoto lens including five lens elements as taught by Kawamura. (APPL-1003), Sasián, ¶101.

Second, Kawamura teaches that its telephoto lens has a ratio of a total track length (TTL) to effective focal length (EFL) of the second lens is smaller than 1. (APPL-1003), Sasián, ¶102.

Specifically, Kawamura's telephoto lens "keeps a compactness of an overall length to a conventional level of a telephoto ratio of about 0.96 to 0.88." (APPL-1007), Kawamura, 1; (APPL-1003), Sasián, ¶103. A POSITA would have understood that a telephoto ratio of Kawamura is a ratio of total track length (TTL)/effective focal length (EFL). (APPL-1003), Sasián, ¶103; *see, e.g.*,

(APPL-1006), Smith, 169 ("The arrangement shown in Fig. 10.1, with a positive component followed by a negative component, can produce a compact system with an **effective focal length F that is longer than the overall length L of the lens**. **The ratio of L/F is called the telephoto ratio**, and a lens for which this ratio is less than unity [(1)] is classified as a telephoto lens."). A POSITA would understand the "telephoto ratio" of Smith is the same as the claimed TTL/EFL ratio, since TTL and L both refer to the overall length of the lens (*see* (APPL-1008), Chen, 3:24-26), and F is described as the effective focal length of the lens system. (APPL-1006), Smith, 169; (APPL-1003), Sasián, ¶103.

Kawamura describes that its telephoto lens satisfies the following conditions, which achieves the telephoto ratio less than one (e.g., "about 0.96 to 0.88"). (APPL-1007), Kawamura, 1-2; (APPL-1003), Sasián, ¶104.

(1) $0.3F < F_{1 \cdot 2 \cdot 3} < 0.5F$

(2) $1.0F < F_{1 \cdot 2 \cdot 3 \cdot 4} < 2.5F$

(3) $0.1F < d_1 + d_2 + d_3 + d_4 + d_5 + d_6 < 0.2F$

(4) $0.1F < d_7 < 0.3F$

(5) $30 < \nu_4 < 50$

(6) $0.1F < r_4 < 0.25F$

(7) $0.05 < n_2 - n_3 < 0.3$

(8) $5 < \nu_3 - \nu_2 < 50$

where F is the "focal length of overall system," $F_{1,2,\ldots i}$ refers to "composite focal

length to ith lens," and d_j refers to "jth surface interval." (APPL-1007), Kawamura, 2.

Specifically, Kawamura explains that condition (1) "is a condition that, in connection with conditions (2) and (3), **indicates an allocation of a focal length necessary to set a telephoto ratio to about 0.96 to 0.88** and form a framework of the telephoto lens that favorably corrects aberration." (APPL-1007), Kawamura, 2; (APPL-1003), Sasián, ¶105.

Furthermore, Kawamura discloses lens prescription data for examples 1-4 supporting that in each of examples 1-4 has a TTL/EFL ratio that is smaller than 1.0. (APPL-1003), Sasián, ¶106. Dr. Sasián has used lens design software ZEMAX to perform lens analysis of each of examples 1-4 of Kawamura. (APPL-1003), Sasián, ¶106, Appendix. Using the lens prescription tables of Kawamura, the lens design software ZEMAX, and the standard wavelength of 587.56 nm (d-line in Kawamura), Dr. Sasián has confirmed that each of the examples 1-4 has a ratio of a total track length (TTL) to effective focal length (EFL) is smaller than 1. *Id*. The table below summarizes the results of those ZEMAX calculations. *Id*. Such a ratio of a total track length (TTL) to effective focal length (EFL) remains unchanged by scaling. *Id*.

	TTL	**EFL**	**TTL/EFL**
Example 1	187.985 mm	200.079 mm	0.939

Example 2	185.891 mm	199.419 mm	0.932
Example 3	179.068 mm	199.692 mm	0.896
Example 4	179.086 mm	199.766 mm	0.896

Accordingly, in the zoom digital camera of combined Golan and Kawamura, a zoom control subsystem 100 includes a tele lens 120 having a five lens element configuration as taught by Kawamura, where a ratio of a total track length (TTL) to effective focal length (EFL) of the tele lens 120 is smaller than 1, which renders obvious that "*a ratio of a total track length (TTL) to effective focal length (EFL) of the second lens is smaller than 1*" as claimed. (APPL-1003), Sasián, ¶107.

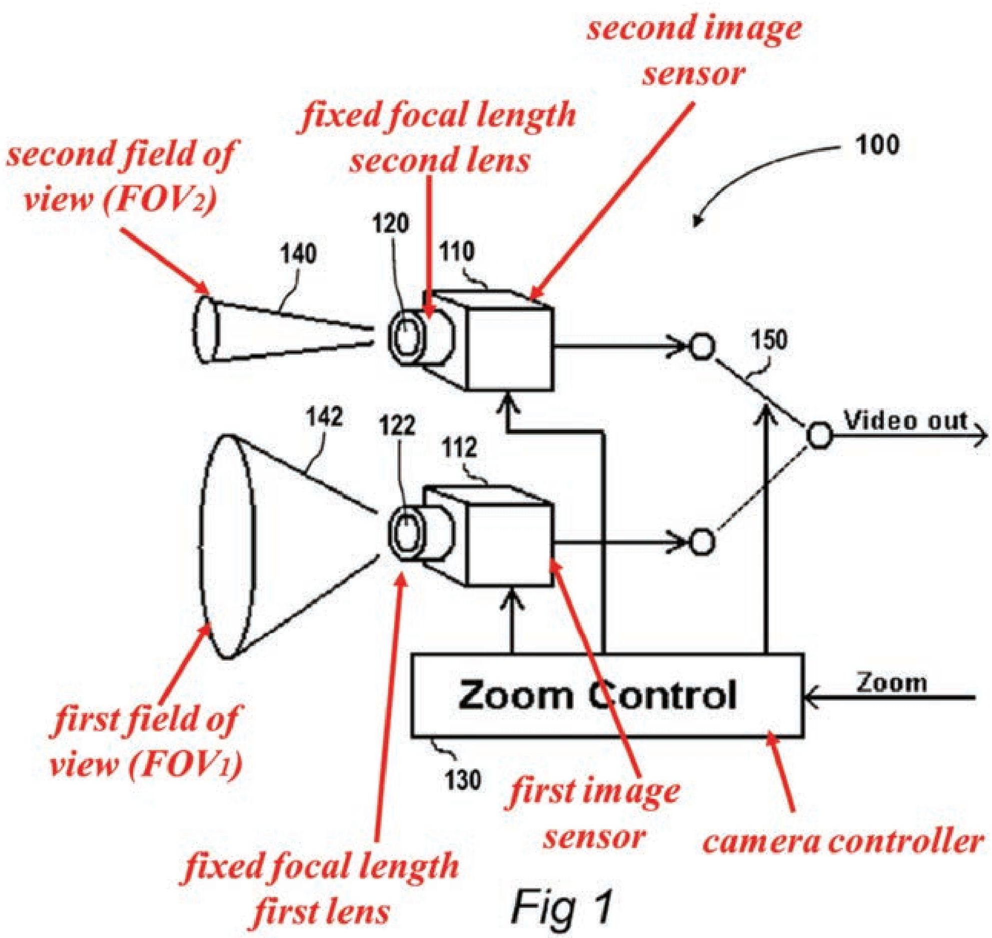
5. Claim 6

[6.1] ***The zoom digital camera of claim 5, further comprising a camera controller operatively coupled to the first and second imaging sections,***

Golan combined with Kawamura renders obvious a camera controller operatively coupled to the first and second imaging sections. (APPL-1003), Sasián, ¶¶108-112.

Specifically, Golan teaches a zoom control sub-system 100 of a digital camera includes a camera controller including a zoom control circuit 130 coupled to the first and second imaging sections. (APPL-1003), Sasián, ¶109. As shown in

annotated Fig. 1 below, Golan describes that "zoom control circuit 130 receives a required zoom from an operator of the image acquisition system, and selects the relevant image sensor (110 and 112) by activating image sensor selector 150 position." (APPL-1005), Golan, [0036]; (APPL-1003), Sasián, ¶109.



(APPL-1005), Golan, FIG. 1, annotated

Golan further teaches that the zoom control circuit 130 "resample[es] the acquired image frame to the requested zoom." (APPL-1005), Golan, Fig. 2, [0048]; (APPL-1003), Sasián, ¶110. Specifically, zoom control circuit 130

"computes the zoom factor between the fixed zoom of the selected image acquisition device and the requested zoom," and "performs electronic zoom on the acquired image frame to meet the requested zoom" based on the computed factor. (APPL-1005), Golan, [0049].

As such, Golan's zoom control circuit 130 is coupled to first and second imaging sections to select one of the first and second imaging sections based on a requested zoom, receives an image frame acquired by the selected imaging section, and performs digital zoom to the acquired image frame to obtain an acquired image frame with said requested zoom. (APPL-1005), Golan, claim 1; (APPL-1003), Sasián, ¶111.

Therefore, in the combination of Golan and Kawamura, zoom control sub-system 100 includes a camera controller including a zoom control circuit 130 coupled to the first and second imaging sections for receiving a requested zoom and provide an acquired image frame with the requested zoom, which teaches "*a camera controller operatively coupled to the first and second imaging sections*" as recited in the claim. (APPL-1003), Sasián, ¶112.

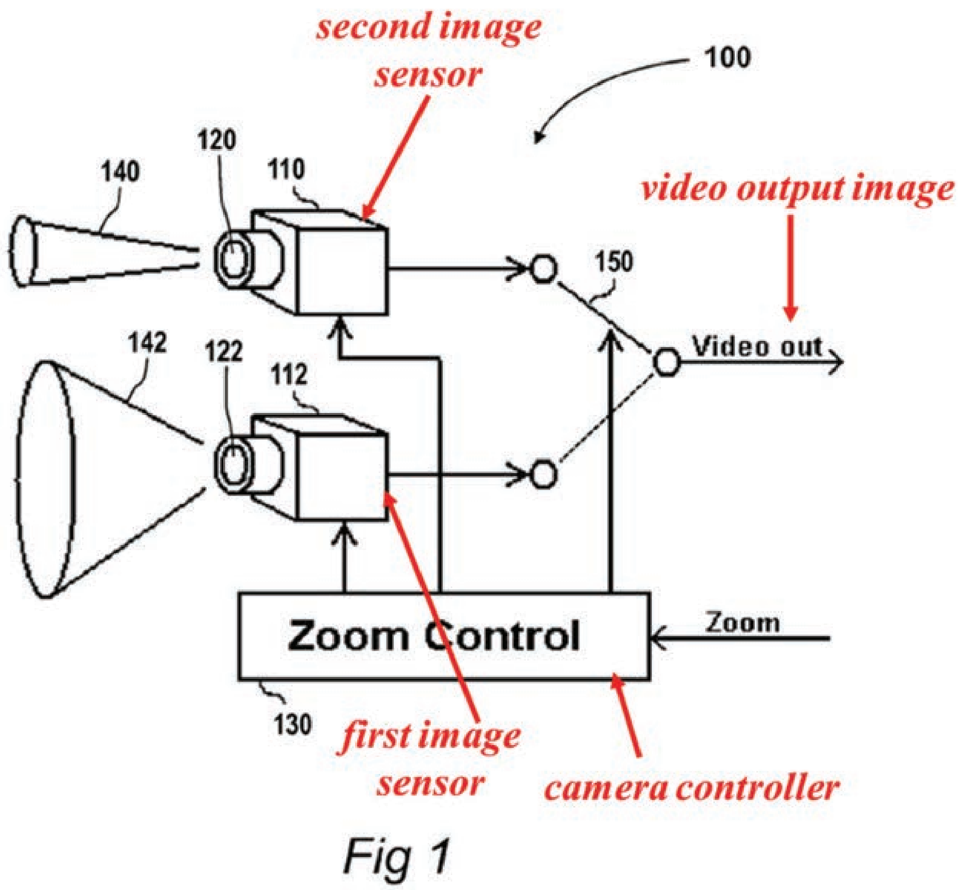
[6.2] ***the camera controller configured to provide video output images with a smooth transition when switching between a lower zoom factor (ZF) value and a higher ZF value or vice versa.***

Golan combined with Kawamura renders obvious that the camera controller is configured to provide video output images with a smooth transition when

switching between a lower zoom factor (ZF) value and a higher ZF value or vice versa. (APPL-1003), Sasián, ¶113-128.

First, Golan discloses providing that a camera controller of its zoom control sub-system 100 is configured "*to provide video output images*" as recited in the claim. (APPL-1003), Sasián, ¶114.

Specifically, as shown in annotated Fig. 1 of Golan below, control sub-system 100 provides video output images, where "zoom control 130 performs **electronic zoom** on the acquired image frame to meet the requested zoom," and "[d]igital zoom is a method for narrowing the apparent angle of view of a digital still or **video image**." (APPL-1003), Sasián, ¶115; (APPL-1005), Golan, Fig. 1; [0003]; [0049]. *See also* (APPL-1005), Golan, [0004] (describing providing "**video streams** (such as PAL, NTSC, SECAM, 656, etc.)").



(APPL-1005), Golan, FIG. 1, annotated

Second, Golan discloses that its zoom control sub-system 100 is configured "*to provide video output images with a smooth transition*" as recited in the claim when switching between two adjacently disposed image sensors, wide image sensor 112 (first image sensor) and tele image sensor 110 (second image sensor). (APPL-1003), Sasián, ¶116.

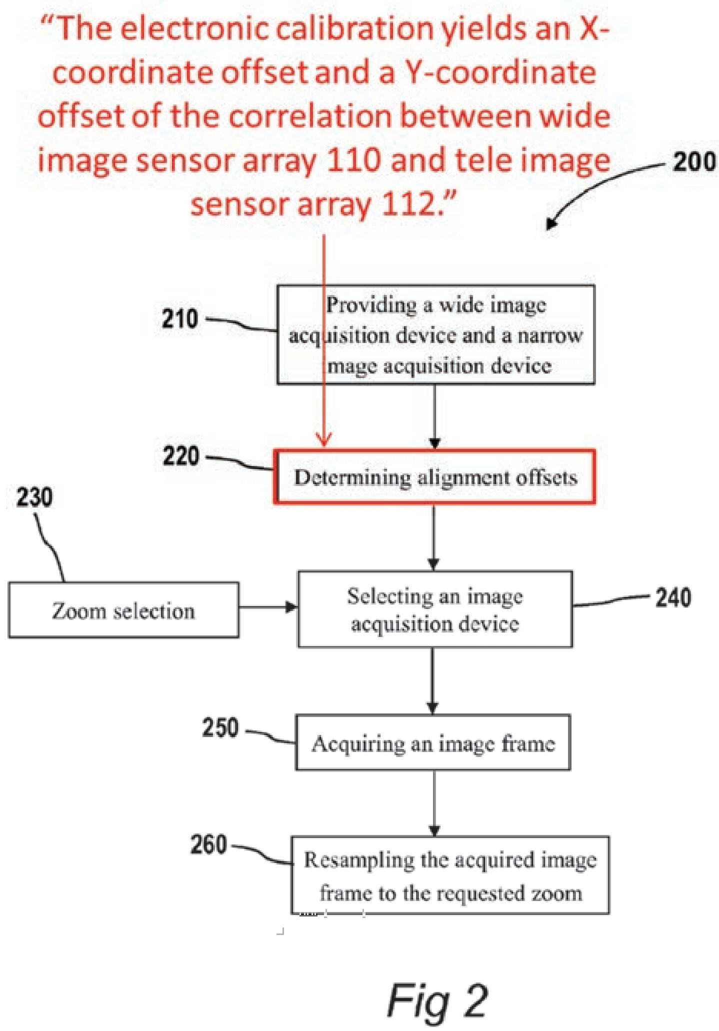
Specifically, Golan teaches a zoom control subsystem 100 providing "**<u>continuous electronic zoom capabilities with uninterrupted imaging</u>**, performed by an image acquisition system having multiple image sensors, each

with a fixed and preferably different FOV," and such "**continuous electronic zoom with uninterrupted imaging is <u>also maintained when switching back and forth between adjacently disposed image sensors</u>**." (APPL-1005), Golan, [0040]; (APPL-1003), Sasián, ¶117.

Because Golan teaches a transition between Wide image and Tele image when switching back and forth between adjacently disposed image sensors that has "uninterrupted imaging," it teaches a transition with a continuous image change. (APPL-1005), Golan, [0040]; (APPL-1003), Sasián, ¶118. As such, Golan's "continuous electronic zoom with uninterrupted imaging" that is "maintained" when switching between Wide and Tele sensors teaches "*smooth transition*" or "transition with a reduced discontinuous image change" as claimed and construed in VI.A. (APPL-1003), Sasián, ¶118.

Golan teaches that electronic calibration to align image sensors may be used to achieve the smooth transition. (APPL-1003), Sasián, ¶119; *see e.g.*, (APPL-1005), Golan, Abstract ("**<u>alignment</u> between the wide image sensor array and the tele image sensor array is computed, to facilitate continuous electronic zoom with uninterrupted imaging, when switching back and forth between the wide image sensor array and the tele image sensor array**."). As shown in FIG. 2 below, in Golan, at step 220 of a continuous zoom process 200 performed on zoom control sub-system 100, "electronically calibrating is performed to determine the **<u>alignment</u>**

offsets between wide image sensor array 110 and tele image sensor array 112,” which “yields an X-coordinate offset and a Y-coordinate offset of the correlation between wide image sensor array 110 and tele image sensor array112.” (APPL-1005), Golan, [0041], [0045]. Those coordinate offsets are computed in high accuracy (e.g., “sub-pixel accuracy”). (APPL-1005), Golan, [0045].



(APPL-1005), Golan, FIG. 2, annotated

A POSITA would have understood that in Golan, by providing "**continuous electronic zoom with uninterrupted imaging, when switching back and forth between the wide image sensor array and the tele image sensor array**" using calibrated alignment offsets between Wide and Tele sensors with high accuracy (e.g., "sub-pixel accuracy"), ((APPL-1005), Golan, Abstract, [0045]), jumps (discontinuousness) in video output images when switching between Wide and Tele sensors (and their corresponding point of views) are minimized. (APPL-1003), Sasián, ¶120.

Third, Golan's switching back and forth between adjacently disposed image sensors, a wide image sensor 112 (first image sensor) and a tele image sensor 110 (second image sensor), teaches "*switching between a lower zoom factor (ZF) value and a higher ZF value or vice versa*" as recited in the claim. (APPL-1003), Sasián, ¶121.

Specifically, Golan teaches that the wide image sensor 112 (first image sensor) is used to provide a video output image having a lower zoom (ZF) value, and a tele image sensor 110 (second image sensor) is used to provide a video output image having a higher ZF value, and as such, switching between wide and tele image sensors teaches switching between video output images having a lower ZF value and a higher ZF value. (APPL-1003), Sasián, ¶122.

Specifically, with reference to FIG. 1 above, Golan describes that an "object 20 is viewed from both tele image sensor 110 and wide image sensor 112, whereas the object is **magnified in** tele image sensor 110 with respect to wide image sensor 112, **by a predesigned factor**." (APPL-1005), Golan, [0037]; (APPL-1003), Sasián, ¶123. A POSITA would have understood that Golan's predesigned factor for magnification teaches a relative magnification ratio of an object in the tele image sensor 110 with respect to the wide image sensor 112, which is used to determine a switch zoom point between Wide and Tele sensors (and corresponding images) for "light weight electronic zoom and a large lossless zooming range." (APPL-1005), Golan, [0007]; (APPL-1003), Sasián, ¶123. For example, Golan teaches "switching between the image sensors provide a lossless electronic zoom of 6^2=36." (APPL-1005), Golan, [0009]. A POSITA would have understood that lossless zooming range of 36 in Golan's example is provided by switching between Wide and Tele sensors at a switch zoom factor depending on the relative magnification ratio of Tele image to Wide image, e.g., by switching at a switch zoom factor equal to 6, performing digital zoom to Wide image for a requested zoom factor between 1 and 6, and performing digital zoom to Tele image for a requested zoom factor between 6 and 36. (APPL-1003), Sasián, ¶123. As such, in Golan, the tele image sensor 110 corresponds to a higher ZF value (for providing an image with a higher magnification, e.g., between 6 and 36) and the wide image

sensor 112 corresponds to a lower ZF value (for providing an image with a lower magnification, e.g., between 1 and 6). *Id.* Further, Golan teaches electronic zooming on either of the sensors, and a POSITA would have understood performing electronic zoom on either sensor also teaches switching between a lower zoom factor to a higher zoom factor, and vice versa. *Id.*

Golan describes that "zoom control circuit 130 receives a required zoom from an operator of the image acquisition system, and selects the relevant image sensor (110 and 112) by activating image sensor selector 150 position." (APPL-1005), Golan, [0036]; (APPL-1003), Sasián, ¶124. As shown in annotated FIG. 2 of Golan below, Golan teaches at step 240, selecting an imaging acquisition device (110 or 112) based on the requested zoom "having a zoom more proximal to the requested zoom." (APPL-1005), Golan, [0047]. As such, Golan teaches that for a requested zoom below a switch zoom factor (e.g., a magnification ratio of tele image sensor 110 with respect to the wide image sensor 112) (corresponds to "*a lower zoom factor (ZF) value*" as claimed), the wide image sensor 112 is selected to provide the acquired image. (APPL-1003), Sasián, ¶124. Similarly, in Golan, for a requested zoom above the switch zoom factor (corresponds to "*a higher ZF value*" as claimed), the wide image sensor 112 is selected to provide the acquired image. *Id.*

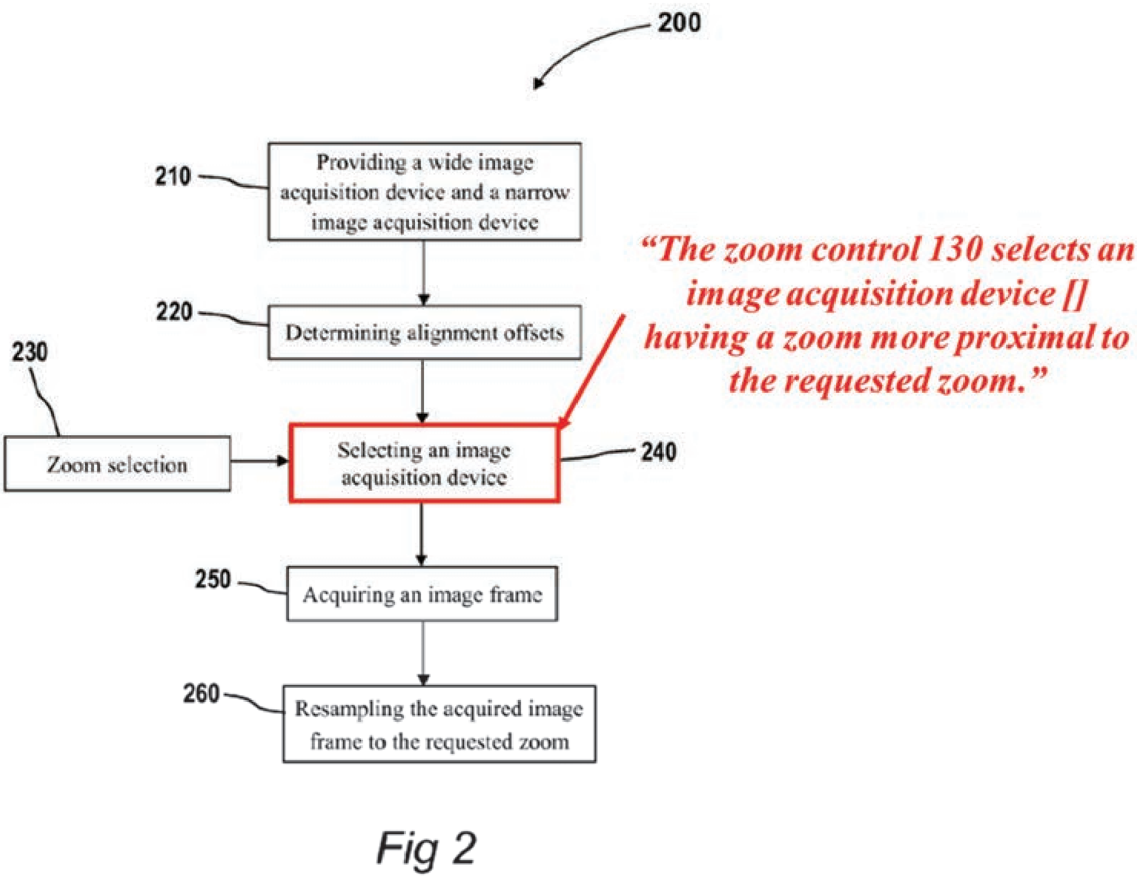


Fig 2

(APPL-1005), Golan, FIG. 2, annotated

Golan further teaches that the zoom control circuit 130 "resample[es] the acquired image frame to the requested zoom," and provides that resampled image as the video output image. (APPL-1003), Sasián, ¶125; (APPL-1005), Golan, FIG. 2, [0048]. As such, Golan's switching back and forth between adjacently disposed image sensors, a wide image sensor 112 (first image sensor) for providing an output video image at a lower ZF, and a tele image sensor 110 (second image sensor) for providing an output video image at a higher ZF, teaches "*switching between a lower*

zoom factor (ZF) value and a higher ZF value or vice versa" as recited in the claim. (APPL-1003), Sasián, ¶125.

As such, because Golan discloses that its zoom control sub-system 100 is configured "*to provide video output images with a smooth transition*" when switching between two adjacently disposed image sensors, and because Golan's switching between two adjacently disposed image sensors teaches "*switching between a lower zoom factor (ZF) value and a higher ZF value or vice versa*" as recited in the claim, Golan teaches that its zoom control sub-system 100 is configured "*to provide video output images with a smooth transition when switching between a lower zoom factor (ZF) value and a higher ZF value or vice versa"* as recited in the claim. (APPL-1003), Sasián, ¶126.

A POSITA would have understood that in the combination of Golan and Kawamura, for providing continuous zoom video output images with a smooth transition when switching, numerous camera design and image processing methods were well known in the art and may be implemented in addition to electronic calibration disclosed in Golan. (APPL-1003), Sasián, ¶127; *see, e.g.*, (APPL-1015), Konno, 14 ("a parallax between the first and second imaging optical systems LN1 and LN2, which is generated depending on the shooting distance" may be compensated "by slightly inclining one of the first and second imaging optical systems LN1 and LN2" or by an "optical camera shake compensation

function"); (APPL-1012), Scarff, 4:12-26 (describing that maintaining similar characteristics in two images (e.g., "brightness and contrast," "amplification," "background noise," "artifacts ... due to subject motion," "depth of field") captured by two image sensors makes "transitions between the two images [captured by two image sensors] more acceptable to the user"); (APPL-1010), Ahiska, 9:44-10:5 (by matching image properties including for example brightness, exposure levels, color between two images from two image sensors to achieve "transition between the master view and the slave view as seamlessly as possible to create the quality of a continuous zoom function").

Accordingly, in the digital camera of Golan and Kawamura, zoom control sub-system 100 includes a camera controller including a zoom control circuit 130 configured to provide video output images with continuous electronic zoom with uninterrupted imaging when switching back and forth between the Wide sensor (providing video image at a lower ZF value less than switch zoom factor) and Tele sensor (providing video image at a higher ZF value greater than switch zoom factor). Therefore, Golan combined with Kawamura renders obvious that "*the camera controller configured to provide video output images with a smooth transition when switching between a lower zoom factor (ZF) value and a higher ZF value or vice versa*" as recited. (APPL-1003), Sasián, ¶128.

X. CONCLUSION

For the reasons set forth above, Petitioner has established a reasonable likelihood that claims 5-6 of the '408 patent are unpatentable. Petitioner requests institution of *inter partes* review and cancelation of claims 5-6.

Respectfully submitted,

Dated: February 5, 2020

/*David W. O'Brien*/
David W. O'Brien
Lead Counsel for Petitioner
Registration No. 40,107

XI. CERTIFICATE OF WORD COUNT

Pursuant to 37 C.F.R. § 42.24, the undersigned attorney for Petitioner declares that the argument section of this Petition (Sections I and III–X) has 9545 words, according to the word count tool in Microsoft Word™.

/David W. O'Brien/
David W. O'Brien
Lead Counsel for Petitioner
Registration No. 40,107

CERTIFICATE OF SERVICE

The undersigned certifies that, in accordance with 37 C.F.R. § 42.6(e) and 37 C.F.R. § 42.105, service is being made on Patent Owner as detailed below.

Date of service	February 6, 2020
Manner of service	USPS Priority Mail Express International®
Documents served	Petition for *Inter Partes* Review, including Exhibit List; Exhibits APPL-1001–APPL-1016
Persons served	Nathan & Associates Patent Agents Ltd P.O. Box 10178 Tel Aviv 6110101 ISRAEL

/*David W. O'Brien*/
David W. O'Brien
Lead Counsel for Petitioner
Registration No. 40,107

For similar reasons, the lenses of Kawamura fail to satisfy other limitations of claim 5. The claim requires a "fourth lens element with negative power," and the petition points to element "L4" to satisfy this limitation. Paper 2 at 35. However, the "fourth lens element" of Kawamura is "L5," a lens element with positive power. Paper 2 at 36.

Similarly, claim 5 requires "a largest distance between consecutive lens elements along the optical axis is a distance between the fourth lens element and the fifth lens element." The petition identifies the distance between "L4" and "L5" as this "largest distance." Paper 2 at 39. But this distance between L4 and L5 is the distance between the third and fourth lens elements, not the distance between the fourth and fifth lens elements as required by the claim.

C. A Person of Ordinary Skill Would Not Have Been Motivated to Combine Golan with Kawamura

Golan teaches the benefits of a camera with "light weight electronic zoom" and teaches away from the use of "heavy and expensive lenses." Ex. 1005, ¶¶ [0007], [0008]. Kawamura, on the other hand, discloses lenses with an "overall length" between 179.068 mm and 187.985 mm, i.e., more than 7 inches long. Paper 2 at 42–44. Golan specifically teaches away from using such a large, heavy lens. The petition suggests that one skilled in the art could have made the Kawamura lens smaller to fit in the digital camera of Golan by

Trials@uspto.gov
571-272-7822

Paper 8
Entered: July 31, 2020

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

APPLE INC.,
Petitioner,

v.

COREPHOTONICS, LTD.,
Patent Owner.

IPR2020-00489
Patent 10,015,408 B2

Before BRYAN F. MOORE, GREGG I. ANDERSON, and MONICA S. ULLAGADDI, *Administrative Patent Judges.*

ULLAGADDI, *Administrative Patent Judge.*

DECISION
Granting Institution of *Inter Partes* Review
35 U.S.C. § 314, 37 C.F.R. § 42.4

I. INTRODUCTION

Patent Owner Corephotonics, Ltd. submits this response to the Petition (Paper 2) filed by Apple Inc., requesting *inter partes* review of claims 5–6 of U.S. Patent No. 10,015,408 (Ex. 1001, '408 patent). The Board granted institution on a single ground of obviousness, based on a combination of Golan (Ex. 1005) with Kawamura (Ex. 1007). Corephotonics submits that the arguments presented herein and the additional evidence submitted, such as the testimony from Patent Owner's expert witness Duncan Moore (Ex. 2003), demonstrate that Apple has failed to establish obviousness of the challenged claims and that Apple's grounds should be rejected.

II. SUMMARY OF ARGUMENT

As explained below, the key premise of Apple's petition that a POSITA would have been motivated to combine dual-camera system of Golan with the lenses from Kawamura is wildly off the mark. Golan dates from 2009 and calls for the use of miniature digital sensors, which a POSITA would have understood to be 1/4 inch or 1/3 inch in diagonal dimension. It does so to achieve its stated goals of light weight and low cost.

Kawamura dates from 1981 and describes massive lenses for film formats larger than even the standard formats of the day. A camera using such a

(Ex. 1001, ’408 patent, Figs. 8 and 9.)

Claim 5 of the ’408 patent claims certain features of the Figure 9 lens design: “five lens elements along an optical axis starting from an object starting with a first lens element with positive power, wherein the five lens elements further include a second lens element with negative power, a fourth lens element with negative power and a fifth lens element, wherein a largest distance between consecutive lens elements along the optical axis is a distance between the fourth lens element and the fifth lens element.” (Ex. 1001, ’408 patent at 14:7–16.) Claim 5 further requires that the ratio of TTL/EFL be smaller than 1. (Ex. 1001, ’408 patent at 14:17–18.)

Another issue addressed in the ’408 patent concerns “jumps” or discontinuities that occur when transitioning from one camera to the other. (Ex. 1001, ’408 patent at 10:37–39.) One cause of discontinuities is a difference in the brightness or color balance between the two cameras. (Ex. 1001, ’408 patent at 10:43–44.) The ’408 patent describes using “secondary information” (e.g., “white balance gain, exposure time, analog gain and color correction matrix”) from one camera to adjust the brightness and color of the image from the other camera to match. (Ex. 1001, ’408 patent at 4:63–5:4.)

A further issue that must be addressed is a difference in the position of objects as seen in the images from the two cameras. This issue is complicated by the effect of "parallax," which causes the position shift for particular objects to be dependent on the distance to the object. (Ex. 1001, '408 patent at 10:45–48.) This effect of parallax can be illustrated by holding a finger in front of one's face and focusing on distant objects. What most people will see is shown in the image below (Ex. 2003, Moore Decl., ¶ 36):

The images captured by the two eyes have matching positions for the distant objections, but the closer object (the finger) is shifted in the two images from the two eyes. (Ex. 2003, Moore Decl., ¶ 37.) If one then focuses the eyes on the finger, the images of the finger will overlap and merge, but there are

American Heritage College Dictionary at 1395.) Dr. Sasián does not argue that Golan teaches the use of a lens that satisfies the limitation requiring a TTL to EFL ratio smaller than 1. (Ex. 1003, Sasián Declaration, ¶¶ 100–107.)

Golan also does not directly specify the dimensions of its image sensors or the weights of its components. (Ex. 2003, Moore Decl., ¶ 51.) However, Golan does provide information that would tell a POSITA what size cameras its contemplated using to achieve its goals of "light weight" and low cost. (*Id.*) Specifically, Golan describes using a digital sensor with approximately 5 megapixels. (Ex. 1005, Golan, ¶ 4.)

To a POSITA that pixel count of 5 megapixels identifies the likely sensor size. (Ex. 2003, Moore Decl., ¶ 52.) The digital sensor accounts for a substantial fraction of the cost of a digital camera, and that cost depends strongly on the area of the silicon wafer occupied by the sensor when it is made. (*Id.*) There are practical limits to how small sensor pixels can be made, due to limitations in fabrication technology and limitations in how finely image features can be resolved on the image plane. (*Id.*) But, there are also limits to how large sensor pixels are made. (*Id.*) If a customer is going to incur the cost of a larger sensor, they are likely going to want the benefits of increasing the pixel count. (*Id.*)

As shown in the following table, published in 2014, the sizes of pixels in available digital sensors remained approximately constant (between 1.4 and 2 microns) with varying sensor size, with the pixel count scaling directly with the sensor area. (Ex. 2003, Moore Decl., ¶ 53.) It is only in the largest, most expensive sensors, having pixel counts in excess of 10 megapixels, that pixels are larger (*Id.*):

TABLE 1.1 Comparison of Camera Formats

(a) Miniature Camera Modules, Digital Cameras, and Film Cameras[a]

Inch-Format	Horizontal (mm)	Vertical (mm)	Diagonal (mm)	Area (mm^2)	Megapixels	Minimum Pixel (mm)	Maximum Pixel (mm)	Linear Scale (35 mm ref) (%)	Area Scale (35 mm ref) (%)	Typical Minimum f/number	EFL	Entrance Pupil Diameter
Miniature Camera Modules												
1/6	2.32	1.74	2.90	4.04	1.3–2	0.0014	0.0017	7	0.4	2	2.28	1.14
1/5	2.80	2.10	3.50	5.88	2–3	0.0014	0.0017	8	0.7	2	2.75	1.37
1/4	3.60	2.70	4.50	9.72	3–5	0.0014	0.0017	10	1.1	2.4	3.53	1.47
1/3	4.80	3.60	6.00	17.28	5–8	0.0014	0.0017	14	1.9	2.8	4.71	1.68
Digital Still Cameras												
1/2.3	6.08	4.56	7.60	27.72	12–16.6	0.0015	0.0022	18	3.1	2.8	6.0	2.1
1/2	6.40	4.80	8.00	30.72	16	0.0014	0.0014	18	3.4	2.4	6.3	2.6
1/1.7	7.44	5.58	9.30	41.52	10–12	0.0019	0.002	21	4.6	2	7.3	3.6
1	13.20	8.80	15.86	116.16	14.2	0.0029	0.0029	37	13	2	12.5	6.2
APS-C	23.60	15.80	28.40	372.88	12.2–24.7	0.0039	0.0055	66	43	2	22.3	11.1
FULL	36.00	24.00	43.27	864.00	18.1–24.7	0.0059	0.0069	100	100	1.4	34.0	24.3
Film Cameras												
Disc	11.0	8.0	13.6	88				31	10	2	10.7	5.3
APS-H	30.2	16.7	34.5	504				80	64	2	27.1	13.5
35 mm	36.0	24.0	43.3	864				100	100	1.4	34.0	24.3
6 × 6 cm	60.0	60.0	84.9	3600				196	385	2.8	66.6	23.8
4 × 5 in.	127.0	101.6	162.6	12903				376	1413	4.5	127.6	28.4

(Ex. 2007, Galstain at 4.)

Based on this table, POSITA in 2009, the earliest priority date for Golan, or in 2013, would have understood that a 5 megapixel sensor was likely to be a 1/4-inch or 1/3-inch sensor, with a diagonal dimension of 4.5 mm or 6.0 mm.

(Ex. 2003, Moore Decl., ¶ 54.) Dr. Sasián appears to agree. During his deposition, he testified that he believes the 5 megapixel sensor described in Golan would have a diagonal of 6.0 mm and semidiagonal of 3.0 mm. (Ex. 2005, Sasián Deposition at 46:10–48:3.) Cameras using sensors of these sizes are considered miniature cameras. (Ex. 2007, Galstain at 4.) As a result, a POSITA reading Golan would recognize that its "light weight" and low cost electronic zoom invention contemplates the use of miniature camera modules. (Ex. 2003, Moore Decl., ¶ 54.)

B. Kawamura

Kawamura was published in 1983 as Japanese Patent Application Publication S58-62609. (Ex. 1007, Kawamura at 1.) It was filed in 1981. (Ex. 1007, Kawamura at 1.) The applicant was Asahi Optical Co., a Japanese camera manufacturer that sold cameras under the Pentax brand. (Ex. 1007, Kawamura at 1; Ex. 2003, Moore Decl., ¶ 55.)

Kawamura describes "a lens of a focal length of about 200 mm for a screen size of 6x7" and provides four examples of such 200 mm focal length lenses. (Ex. 1007, Kawamura at 1, 3–5.) It also refers to the possibility of "a focal length of about 150 mm for a screen size of 4.5x6," but it does not provide any examples of such a lens. (Ex. 1007, Kawamura at 1.)

formation performance" including "decreasing chromatic aberration in magnification" (*id.*; Ex. 1007, Kawamura at 1), one of the odd-order aberrations that cancels as a result of placing the aperture stop near the center of the lens assembly (Ex. 2003, Moore Decl., ¶ 72; Ex. 2009, Sasián Introduction to Aberrations at 73–74).

VIII. OBVIOUSNESS

A. Claim 5 Is Not Obvious over Golan in Combination with Kawamura

A POSITA would not have been motivated to utilize the Kawamura lens designs in the Golan system, either unmodified or scaled to a smaller size. (Ex. 2003, Moore Decl., ¶ 73.)

1. Using Kawamura Unmodified in Golan

To the extent that Apple argues that a POSITA would use the Kawamura lenses in Golan without modification, this is incorrect. (Ex. 2003, Moore Decl., ¶ 74.) As explained above, the goal in Golan was to avoid "heavy and expensive lenses" and to achieve "light weight electronic zoom." (Ex. 1005, Golan, ¶¶ 7–9.) In the context of camera design, the 7-inch Kawamura lenses would have been considered "heavy," both in 1981 when Kawamura was filed and in 2009 on Golan's asserted priority date. (Ex. 2003, Moore Decl., ¶ 74.)

Mechanical zoom lenses much lighter than the unscaled Kawamura lenses were commonly available for 35 mm and smaller cameras. (*Id.*)

This conclusion is further strengthened by the fact that Golan contemplates use of 5 megapixel digital sensors. (Ex. 2003, Moore Decl., ¶ 75.) As explained above, 5 megapixel sensors commonly had dimensions of 2.7 mm x 3.6 mm or 3.6 mm x 4.8 mm, much smaller than the 56 mm x 67 mm film size Kawamura's lenses were designed for. (*Id.*; Ex. 2007, Galstain at 4.) A common 5 megapixel sensor would cover between 0.25% and 0.46% of the area covered by the film Kawamura was designed for, i.e., it is smaller by a factor of 200x or 400x in area. (Ex. 2003, Moore Decl., ¶ 75.) Using such a massive lens with a tiny 5 megapixel sensor would be extremely unusual and would result in an extremely cropped image of the scene. (*Id.*) No POSITA would be motivated to do this. (*Id.*)

2. Scaling Kawamura to Use in Golan

Apple is also incorrect to argue that a POSITA would have been motivated to scale Kawamura for use in Golan. (Ex. 2003, Moore Decl., ¶ 76.) At the time that Golan was written, Kawamura's design was 28 years old. (*Id.*) Substantial improvements in computation power, design techniques, materials, and manufacturing techniques meant that lenses made in 2009 or in 2013

were substantially improved in performance and other characteristics over even high-quality lenses designed in 1981. (*Id.*)

Kawamura's lenses were also designed for a different purpose, with different design constraints, than a lens for the Golan system. (Ex. 2003, Moore Decl., ¶ 77.) As explained above, the 5 megapixel sensor described in Golan would typically have had a diagonal size of 4.5 mm or 6.0 mm. (*Id.*; Ex. 2007, Galstain at 4.) Applying the Pythagorean theorem, a 56 mm x 67 mm rectangle of film has a diagonal size of approximately 87 mm. (Ex. 2003, Moore Decl., ¶ 76.) So, the Kawamura lens would need to be scaled down by a factor of around 14x to 20x in order provide the same field of view on a 5 megapixel sensor. (*Id.*) Dr. Sasián appears to generally agree, as he estimated during his deposition that the Kawamura lens would be scaled by a factor of 10x. (*Id.*; Ex. 2005, Sasián Deposition at 47:24–48:3.)

a. Scaling Lens Designs by a Large Factor Is Not Done in Practice

Dr. Sasián's brief discussion of lens scaling suggests that scaling by large factors is routine and would be expected to result in a well-performing lens. (Ex. 1003, Sasián Declaration, ¶ 64.) This is incorrect. (Ex. 2003, Moore Decl., ¶ 78.) While it is true that from the standpoint of the geometric optics of an ideal lens design, scaling that design will also scale the aberrations of

the design and leave many dimensionless properties of the lens design unchanged, that does not does not mean that the resulting design will be practical or useful. (*Id*.) There is more to a good lens design than the geometric optics of a lens perfectly fabricated to the design. (*Id*.) Scaling a design can dramatically alter the practicality of manufacturing the design and its sensitivity to variations in manufacturing. (*Id*.) In addition, the most important performance characteristics for judging a lens design (including parameters such as f-number, field of view, and manufacturing tolerances) will change with the scale of a lens, meaning that scaling a good conventional lens design to a smaller size will often produce a design that is substantially inferior for its intended purpose to designs that were specifically created to be used as small lenses. (*Id*.)

Dr. Sasián and his Ph.D. students have acknowledged the impracticality of scaling conventional lens designs to miniature size in their academic writings, as have others in the field, both prior to Golan's filing date and after. (Ex. 2003, Moore Decl., ¶ 79.)

For example, Dr. Sasián and his Ph.D. student Dmitry Reshidko wrote in 2015:

> A traditional objective lens ***can not be simply scaled down*** as a lens solution due to fabrication constraints, materials properties, manufacturing process, light diffraction and geometrical aberrations.

(Ex. 2008, Reshidko and Sasián at E216.)

In the same paper, Dr. Sasián wrote that "[t]he practically achievable ratio of the total length to the focal length in lenses for mobile cameras is between 1.15 and 1.3 [12]." (Ex. 2007, Reshidko and Sasián at E217.) This further illustrates the difficulties of scaling conventional lenses to miniature size. Otherwise, Dr. Sasián's statement would make no sense. (Ex. 2003, Moore Decl., ¶ 81.) Telephoto lenses with a ratio of the total length to the focal length less than 1.0 were first achieved in the 1800s and were widely used in film cameras and other applications in the twentieth century. (*Id.*) If simple scaling of these conventional lenses would produce practical lenses, then Dr. Sasián would not have written in 2015 that 1.15 was the lowest ratio of the total length to the focal length that was "practically achievable." (*Id.*)

Dr. Sasián's student Yufeng Yan[1] explained in his Ph.D. dissertation that "that the design approaches and lens constructions are significantly different between a miniature camera lens and a conventional camera lens" and that "if the conventional camera lens was simply scaled down to the same focal length of the miniature lens, it would encounter many issues." (Ex. 2013, Yan at 79.)

---

[1] Dr. Yan currently works as an optical engineer at Apple. https://www.linkedin.com/in/yufengyan/

Yan further explained: "Scaling down a conventional camera lens requires spatial tolerances to scale down with the same ratio, which is about the factor of 7. This creates a huge problem on the tolerance budget of element and surface decenter." (Ex. 2013, Yan at 83.)

The fact that scaling of conventional lens designs to miniature size is impractical was known prior to 2009, as explained a paper by Bareau and Clark that Dr. Sasián cites in his textbook (Ex. 2006, Sasián at 195) and that Apple has relied upon as a prior art reference in another IPR challenging a Corephotonics patent (IPR2018-01146, Ex. 1012). Bareau and Clark state:

> When designing a camera module lens, it is not always helpful to begin with a traditional larger-scale imaging lens. ***Scaling down such a lens will result in a system that is unmanufacturable***. . . . For glass elements, the edge thicknesses will become too thin to be fabricated without chipping. To achieve a successful design we have to modify our lens forms and adjust the proportions of the elements.

(Ex. 2012, Bareau at 1.) Bareau and Clark describe a number of issues that arise when scaling a 35 mm lens to a lens for a 1/4-inch sensor: "smaller entrance pupil" leading to greater depth of field and more sensitivity to diffraction, tighter "surface figure tolerances," tighter "geometric tolerances," tighter "angular tolerances," "stray light considerations," and "scratch/dig and contamination." (Ex. 2012, Bareau at 3.)

Dr. Sasián further explains the manufacturing problems encountered when lens designs become smaller in his textbook on lens design. He explains that for miniature lenses, “lens tolerances for lens thickness and decenter become tighter.” (Ex. 2006, Sasián at 187.) Dr. Sasián elaborates:

> “As mentioned before, one problem with the small scale of miniature lenses is that lens element thickness and decenter errors can have a large impact by decreasing performance. For example, a thickness error of 0.1 mm can be tolerable in a 50 mm focal length lens, but not at all in a miniature lens with a focal length of 5 mm. Therefore, an important part of the lens design is to desensitize as much as possible a given design.”

(Ex. 2006, Sasián at 192.)

Bareau and Clark also describe the importance of desensitizing a miniature lens design: “One of the most challenging aspects of designing lenses for camera modules is desensitizing the system. If sensitivity to manufacturing tolerances is not built into the merit function, ***then the lens will not be manufacturable***.” (Ex. 2012, Bareau at 9.)

A POSITA would recognize that a conventional lens designed for medium-format film, such as that in Kawamura, would not be desensitized as required if it were scaled down by a factor of 14 to 20. (Ex. 2003, Moore Decl., ¶ 86.) This is especially true of a lens designed in 1981, when the computer simulation abilities to study and reduce lens sensitivity were limited.

(*Id.*) For this reason, a POSITA in 2009 or in 2013 would not expect the Kawamura lens to be successful if scaled down for use in Golan. (*Id.*) Dr. Sasián's declaration is silent on this important issue. (*Id.*)

A POSITA in or around 2013 simply would not have looked to a 200-mm lens designed in 1981 in selecting a design for Golan's narrow lens. (Ex. 2003, Moore Decl., ¶ 87.) Rather, the POSITA would look to designs that were purpose-made for miniature cameras and that took advantage of three years of technological improvement. (*Id.*) As Dr. Sasián explains in his textbook, evolutionary development from existing miniature lens designs is the standard approach in the field: "[m]obile phone lenses have been evolutionary, in that every generation increased complexity from the previous one." (Ex. 2006, Sasián at 190.) There was also no shortage of miniature lens designs for a POSITA to use or to improve on: "[t]he patent literature has hundreds of lens design examples for mobile phone lenses and their forerunners, personal digital assistants." (Ex. 2006, Sasián at 190.) A POSITA would not have been motivated to go beyond rich literature of miniature lens designs and try scaling old lenses, designed for different purposes, with little reason to expect the result would be manufacturable. (Ex. 2003, Moore Decl., ¶ 87.)

looked to existing miniature lens designs, rather than the old Kawamura design, directed to an entirely different purpose. (*Id.*)

B. Claim 6 Is Not Obvious over Golan in Combination with Kawamura

Dependent claim 6 requires a "smooth transition" when switching between a lower zoom factor (ZF) value and a higher ZF value or vice versa. Dr. Sasián opines that Golan satisfies this requirement. (Petition at 44–57; Ex. 1003, Sasián Declaration, ¶¶ 113–128.) This is incorrect. (Ex. 2003, Moore Decl., ¶ 112.)

As explained above, the term "smooth transition" in the context of the '408 patent means a transition that minimizes the jump effect such that there is no jump in the ROI region. (Ex. 2003, Moore Decl., ¶ 113.) Golan does not disclose such a smooth transition. (*Id.*)

Golan does not discuss or refer to the concept of a region of interest, and it does not teach any means of preventing a jump in the ROI region. (Ex. 2003, Moore Decl., ¶ 114.) Instead, Golan teaches using alignment offsets from an electronic calibration step that is "performed one time" which is "before the first use." (Ex. 1005, Golan, ¶ 38.) Offsets from such a one-time calibration cannot address the jumps of different sizes that result from objects at different distances as a result of parallax. (Ex. 2003, Moore Decl., ¶ 114.) Because the

offsets are determined before the first use of the system and before a particular region of interest could be known, they cannot avoid a jump specifically within the region of interest. (*Id.*)

Apple and Dr. Sasián also briefly cite to portions of Ahiska (Ex. 1010), Scarff (Ex. 1012), and Konno (Ex. 1015) in connection with this this claim term. (Petition at 55–56; Ex. 1003, Sasián Declaration, ¶ 127.) These are not part of the obviousness combination proposed by Apple, but are at most rather evidence of what one skilled in the art might have known. Dr. Sasián provides no explanation of how any of these references would have motivated a POSITA to avoid jumps in position for a region of interest specifically in the Golan (or Golan plus Kawamura) system. (Ex. 2003, Moore Decl., ¶ 115.)

Indeed, the only one of these references that Apple or Dr. Sasián quotes as addressing jumps of position at all is Konno. (Petition at 55–56; Ex. 1003, Sasián Declaration, ¶ 127.) Konno mentions the issue of "parallax," but it does not mention or suggest addressing the issue of parallax specifically for a region of interest, and Dr. Sasián's discussion of Konno does not address the region of interest issue either. (Ex. 2003, Moore Decl., ¶ 116.) Further, the solution that Konno suggests is a mechanical solution, tilting the two cameras or using an "optical camera shake compensation function." (*Id.*; Ex. 1015,

Konno at 14.) Golan specifically teaches away from such mechanical solutions, describing its sensors as "static" and not needing "moving mechanical elements." (Ex. 1005, Golan, ¶¶ 7–8; Ex. 2003, Moore Decl., ¶ 116.) It also specifically teaches that the "spatial offsets" between its sensors are "fixed" and can be measured a single time after manufacture. (Ex. 1005, Golan, ¶ 38; Ex. 2003, Moore Decl., ¶ 116.) It would be contrary to the teachings of Golan to add a complicated mechanical system to vary the positions of its two cameras, along the lines of Konno. (Ex. 2003, Moore Decl., ¶ 116.)

IX. CONCLUSION

For the reasons set forth above, Corephotonics respectfully requests that the Board affirm the validity of claims 5–6 of the '408 patent.

Dated: November 25, 2020

/Neil A. Rubin/

Neil A. Rubin (Reg. No. 67,030)
RUSS AUGUST & KABAT
12424 Wilshire Boulevard, 12th Floor
Los Angeles, CA 90025
Telephone: 310-826-7474

Attorney for Patent Owner,
COREPHOTONICS, LTD.

dependent claims 2 and 3 "**matching scale**" and "**to match brightness and color**" respectively).

III. Claim 5 is Obvious over Golan in Combination with Kawamura.

Patent Owner argues that claim 5 is not invalid because "[a] POSITA would not have been motivated to utilize the Kawamura lens designs in the Golan system, either unmodified or scaled to a smaller size." Response, 32. Patent Owner does not directly dispute any particular limitation of claim 5.

As explained below, Patent Owner's argument of no motivation to combine Golan and Kawamura is based on its incorrect premise that Golan's digital camera teachings are limited to a **miniature camera** allegedly requiring **miniature lenses**, based on legally incorrect analysis based on computer simulation abilities and lens fabrication technology in 1981, and based on opinion testimony unsupported by any underlying lens design software analysis. Patent Owner's arguments should be rejected for each of these reasons.

A. Patent Owner mischaracterizes Golan as limited to miniature cameras using miniature lenses.

Patent Owner argues that Golan "calls for the use of miniature digital sensors," (Response, 1), and that because cameras using such sensors are "considered miniature cameras," Golan "contemplates the use of miniature camera modules." Response, 21. However, a POSITA would have understood that

Golan's teachings are not limited to miniature cameras. APPL-1013, ¶15. Patent Owner's no motivation to combine arguments are based on the incorrect understanding that Golan is limited to miniature cameras using miniature lenses, and should be rejected.

1. Golan's teachings include non-miniature cameras using non-miniature lenses.

A POSITA would have understood that Golan's teachings are not limited to miniature cameras used in mobile devices such as cellphones, and instead include applications for conventional digital still cameras and other commercial, industrial and security applications including air-born vehicles/drones applications. APPL-1013, ¶16. Specifically, Golan never mentions "miniature," and does not establish a dimension limitation on either its imaging system or image sensors. As such, a POSITA would have understood that Golan's teachings apply to imaging systems of various sizes using any suitable image sensors. *Id.*

A POSITA's understanding of the applicability of Golan's teachings to applications beyond the mobile device realm is confirmed by other disclosures from Golan's inventors and assignee, NextVision Stabilized Systems Ltd. ("NextVision"). APPL-1013, ¶17. *See* APPL-1034 (approximately 4:04 minutes of video capture including authentication (0:00-0:50min) of flash content retrieved from an archive.org crawl of the nextvision-sys.com website of September 2, 2012, depiction (0:50-1:12min) of Nextvision and MicroCam-D product information, and

video (1:22min) from MicroCam-D on a flying drone with "digital zoom" at 2:44min and 3:21min); APPL-1035 (captured from APPL-1034 at 0:52min and reproduced below, illustrating dimensions of MicroCam-D); APPL-1022, 1:14-18 (NextVision patent describing an imaging system "mounted on an air-born vehicle"); APPL-1024, 2 (describing an unmanned aviation vehicle using "MicroCam D from Nextvision"); APPL-1026; APPL-1030, 2.

APPL-1035 (Captured From APPL-1034 at 0:52min)

2. Patent Owner's mischaracterization of Golan is based on its improper reliance on Golan's example 5-Megapixel image sensor.

Patent Owner argues a POSITA would not have used the Kawamura lens unmodified in Golan because of Golan's use of "a tiny 5 megapixel sensor." Response, 33. Patent Owner further argues that a POSITA would not have scaled the Kawamura lens to Golan because "the Kawamura lens would need to be scaled down by a factor of around 14x to 20x in order to provide the same field of view on a 5 megapixel sensor," and such "scaling of conventional lens designs to miniature size is impractical." Response, 34, 37. Patent Owner's arguments should be rejected because they improperly rely on Golan's example 5-Megapixel image sensor as a requirement, because they fail to recognize that a POSITA would have used other sensors (e.g., of different megapixel number or different dimensions) in Golan's systems, and because scaling to accommodate a sensor size was practical and with the skill of a POSITA, as demonstrated by Dr. Sasián. APPL-1013, ¶18.

Golan provides, "**[f]or example**, having a 5 Megapixel, 2592x1944, image sensor array and an output resolution frame of 400x300 yields maximal lossless electronic zoom of 6.48." APPL-1005, [0004]. A POSITA would have understood that Golan's description of the 5-megapixel image sensor array is merely an example, not a requirement. APPL-1013, ¶19. Patent Owner's own

expert agrees that because Golan only "uses this [5-megapixel image sensor array] **as an example**," "there must be – may be **other choices**." APPL-1017, 141:14-15.

Patent Owner states, without providing a citation, "even Apple's expert agrees, using Kawamura's lenses in Golan would require scaling it down by more than a factor of 10." Response, 2. But Dr. Sasián never provided such agreement. On the contrary, Dr. Sasián explains that scaling is "depending on the choice of image sensors," and scaling down the lens prescriptions in Kawamura by a factor of roughly ten for an example 5-megapixel sensor in Golan is only "one possibility." EX. 2005, 47:15-17; 49:4-18; APPL-1013, ¶20.

Furthermore, even if Golan were limited to a 5-megapixel sensor, Patent Owner's argument that this requires a 1/4" or 1/3" sensor is incorrect, and in fact, contrary to its own expert's testimony. *See, e.g.*, Response, 1, 20; APPL-1017, 133:2-6 (Patent Owner's own expert stating that he does not believe Golan provides a required image sensor size). A POSITA would have understood that image sensors of different dimensions, for example, a 1/2.5" sensor, may be used in Golan. *See* APPL-1029, 62 (describing using a 1/2.5" CCD image sensor in a dual lens digital camera to provide a 5.3-megapixel image); APPL-1013, ¶21.

3. Patent Owner's mischaracterization of Golan is further based on its misunderstanding of how Golan achieves "light weight electronic zoom."

Patent Owner argues that Golan uses miniature digital sensors (1/4" or 1/3" sensor format) "to achieve its stated goals of light weight and low cost." Response, 1. Patent Owner's argument misapprehends how Golan achieves "light weight electronic zoom," and should be rejected. APPL-1013, ¶22.

Golan describes that a camera with a single optical zoom lens having a large dynamic zoom range typically requires "heavy and expensive lenses." APPL-1005, [0007]. An example of such a heavy and expensive lens is a Fujinon A36X14.5 lens, an optical zoom lens providing a zoom ratio of 36x. APPL-1027, 1; APPL-1013, ¶23. The Fujinon A36X14.5 lens is heavy with a weight of 4.58kg (about 10 pounds) and a length of 363.3 mm (about 14.3"), and is expensive (e.g., a used one priced on eBay for over $10,000). *Id.*; APPL-1028, 1.

To achieve "light weight electronic zoom," Golan replaces a single optical zoom lens with two fixed focal length lenses and "two (or more) image sensors, having different fixed FOV" to achieve light weight electronic zoom with a large lossless zooming range. APPL-1005, [0009]; APPL-1013, ¶24; APPL-1017, 137:20-24 (Patent Owner's own expert testified that Golan's light weight digital zoom is achieved by using a wide lens and a telephoto lens instead of using a single conventional zoom lens).

A POSITA would have understood that, in Golan, the terms "heavy," "expensive," and "light weight" are relative. APPL-1013, ¶25. For example, compared to a camera with a single Fujinon A36X14.5 lens, according to Golan's teachings, a POSITA could and would have achieved light weight digital zoom of 36x by using a wide lens and a telephoto lens (e.g., based on Kawamura's lens design) that are **cheaper** and **lighter** than the Fujinon A36X14.5 lens. As such, Golan does not require using 1/4" or 1/3" miniature digital sensors to achieve a cheaper lightweight digital zoom.

Additionally, Patent Owner's own expert admits that lightweight cameras may be used in applications including drones, endoscope applications, and space applications, without using miniature lenses as defined in the context of cellphone. APPL-1017, 143:16-145:19; 148:16-19.

It is worth noting that Patent Owner's expert has worked on cameras for drones, (APPL-1017, 146:15-18) and admitted that "weight is incredibly important" in drones because "the most important thing is how long can you keep the drone up there. And the lighter it is, the better." *Id.*, 147:7-14. However, Patent Owner and its expert completely fail to consider drone applications (e.g., gimbal-stabilized cameras for drones) when evaluating motivations to combine Golan and Kawamura. APPL-1017, 164:13-165:18.

B. A POSITA would have looked to the Kawamura design in selecting a design for Golan's tele lens.

1. Patent Owner's no motivation to combine arguments are based on misunderstanding of "heavy" and "lightweight" in Golan and based on incorrect calculation of the scaling factor for using a Kawamura lens in Golan.

First, regarding using Kawamura unmodified in Golan, Patent Owner argues that, a POSITA would not have been motivated to do so because "the goal of Golan was to avoid 'heavy and expensive lenses'," and in the context of camera design, "the 7-inch Kawamura lenses would have been considered 'heavy'." Response, 32. Patent Owner's argument, based on misunderstandings of Golan's use of "heavy," "expensive," and "light weight," and how Golan achieves "light weight electronic zoom," should be rejected. APPL-1013, ¶26.

As discussed above at III.A.3, in Golan, the terms "heavy," "expensive," and "light weight" are relative. As such, compared to a camera with a single optical zoom lens (e.g., Fujinon A36X14.5 lens), in the combination of Golan and Kawamura, a POSITA would have achieved light weight digital zoom of 36x by using a wide lens and a telephoto lens based on Kawamura's lens design that are cheaper and lighter than that single optical zoom lens. APPL-1013, ¶27.

Patent Owner further argues that a POSITA would not have used Kawamura unmodified in Golan because Golan's sensors dimensions are much smaller than a 56mm x 67mm film size of Kawamura. Response, 34. However, as explained at

V.A, Golan does not establish sensor dimension limitations and, when applying Golan's teachings, a POSITA would have used image sensors of dimensions suitable for a particular application, including sensors with sizes similar to a film size of Kawamura. APPL-1013, ¶28; *see, e.g.*, APPL-1031, 2:31-45 (describing using a 60mm x 45mm image sensor in applications including unmanned aerial vehicles); APPL-1032, 1:10, 25-26 (using a 24 mm x 36 mm image sensor in applications including unmanned aerial vehicles); APPL-1013, ¶28.

Second, Patent Owner argues a POSITA would not have been motivated to scale Kawamura because "Kawamura lens would need to be scaled down by a factor of around 14x to 20x in order provide the same field of view on a 5-megapixel sensor," and because allegedly "scaling lens designs by a large factor is not done in practice." Response, 34. Patent Owner's requirement for such a large scaling factor is incorrect because it is based on an example 5-megapixel sensor of Golan and unwarranted presumptions regarding the dimensions of such a sensor, and ignores other possible sensor formats for Golan. APPL-1013, ¶29. Furthermore, Patent Owner's calculation completely ignores any field of view adjustment to the Kawamura lens a POSITA would have performed when combining Golan and Kawamura. *Id.*

As explained by Dr. Sasián with examples in Table 1 of the supporting declaration, in the combination of Golan and Kawamura, a POSITA would have

understood that sensors of various formats may be used in the combination of Golan and Kawamura based on the application, would have applied the appropriate scaling factor based on the image sensor format (e.g., scaling factors less than 10 for image sensors of 1/3" or greater), and would have found that modification of Kawamura's lens for the combination is practical. APPL-1013, ¶¶30-31; Table 1. Further, a POSTA would have found it practical, and indeed, would have modified the field of view of Kawamura's lens for a tele field of view that's appropriate for a particular application (e.g., conventional digital still cameras, air-born vehicles/drones applications, etc.), including the example Narrow_FOV described in Golan. *Id.* Dr. Sasián confirms, based on ZEMAX analysis within the skills of a POSITA, successful scaling of representative Kawamura Example 1 in a combination of Golan and Kawamura (e.g., with a scaling factor of 6.4 with a 1/3" image sensor and a full angle tele FOV of 10.98°). *Id.,* ¶33, Appendix.A.

2. Patent Owner's list of miniature telephoto lens requirements should be rejected because they are based on mischaracterizing Golan as limited to miniature camera using miniature lenses.

Patent Owner alleges a list of miniature telephoto lens requirements for a telephoto lens in Golan including (1) a scaling factor of 10x or more for Kawamura, (2) an aspheric design with plastic elements, (3) an aperture stop near the first lens element, and (4) a small F-Number between 2 and 3. Response, 33-51. As discussed above at III.A, Golan's teachings include non-miniature cameras

using non-miniature lenses. Because each of these alleged requirements is premised on Patent Owner's mischaracterization of Golan as limited to miniature cameras using miniature lenses, all of these alleged miniature lens requirements should be rejected. APPL-1013, ¶34.

3. Patent Owner's argument that a POSITA would have looked to one of the hundreds of known miniature lens designs, instead of Kawamura, when looking for lens to use in Golan is based on mischaracterization of Golan and its tele lens.

Patent Owner argues that "the evidence shows that a POSITA would have looked to one of the **hundreds** of known **miniature** lens designs when looking for a lens to use in Golan," and therefore a POSITA would not have looked to Kawamura. Response, 2-3. Patent Owner's argument fails because it again is based on the incorrect premise that Golan requires miniature lens. APPL-1013, ¶35.

First, as discussed above at III.A, Golan does not have any dimension limitation on its imaging system or lenses, and does not require miniature lens. As such, a POSITA would have looked to conventional lens design, such as Kawamura's lens design, when looking for lens to use for the tele lens of Golan, if appropriate for the POSITA's application. APPL-1013, ¶36. A POSITA would have looked to Kawamura's lens design because it provides a telephoto lens that "keeps a **compactness of an overall length** to a conventional level of a telephoto

ratio of about 0.96 to 0.88 but has **an excellent image-formation performance**." APPL-1007, 1; (APPL-1003), ¶62. Specifically, Kawamura's design provides a telephoto ratio less than 1 (e.g., .96 to .88), which means a ratio between an overall length and focal length is .96 to .88, and as such, providing a desirable "compactness of an overall length" (by reducing the overall length of the lens to be less than the focal length) with an excellent image-formation performance. APPL-1013, ¶36.

Kawamura's "conventional level of a telephoto ratio of about 0.96 to 0.88" remains desirable for lens design in 2013, the priority date of the '408 patent. APPL-1013, ¶37. The Institution Decision invites parties to address an issue related to Kawamura, noting that "the year of Kawamura's publication, 1983, is relevant to its discussion of a telephoto lens 'that keeps a compactness of an overall length to a *conventional* level." Institution Decision, 20 (citing Kawamura, 1). That quotation from Kawamura is incomplete, and as such incorrectly suggests that a "conventional level" may be keyed to the year of Kawamura's publication. The complete statement of Kawamura provides,

> An object of the present invention is to provide a lens that keeps a compactness of an overall length to **<u>a conventional level of a telephoto ratio of about 0.96 to 0.88</u>** but has an excellent image-formation performance due to favorably correcting spherical aberration of both a reference wavelength and color and also decreasing chromatic aberration in magnification.

(APPL-1007), Kawamura, 1. A POSITA would have understood that Kawamura provides clear description for the meaning of "a *conventional* level," which refers to a level "of a telephoto ratio of about 0.96 to 0.88," and such a meaning is not affected by the publication date of Kawamura. APPL-1013, ¶37.

Second, even assuming Golan required miniature lenses, which it clearly does not, Patent Owner fails to present evidence that its alleged "hundreds of known miniature lens designs" includes a telephoto miniature lens design that a POSITA would have looked to use as the tele lens in Golan.[2] APPL-1013, ¶38. In

---

[2] A POSITA would have understood that Golan's tele lens 120 teaches using a telephoto lens, and would have been motivated to use a telephoto lens as Golan's tele lens 120 to achieve a more compact camera. APPL-1013, n1; APPL-1006, 169 (describing that a telephoto lens produces "a **compact system** with an effective focal length F that is longer than the overall length L of the lens."); APPL-1033, 6:51-52. A telephoto lens, by definition, has a telephoto ratio smaller than 1 ("less than unit"). *See, e.g.*, APPL-1006, 169 ("The ratio of L/F is called the telephoto ratio, and a lens for which this ratio is less than unit is classified as a telephoto lens."); APPL-1008, 3:24-26.

fact, Patent Owner and its own expert fail to provide even a single example of a miniature telephoto lens design that a POSITA would have looked to. APPL-1017, 128:5-22 (Patent Owner's own expert admitting that he does not know any reference providing a miniature telephoto lens design on or before 2013).

C. Patent Owner's analysis is incorrect because it is based on a POSITA's understanding of technology in 1981 and incorrect understanding of ongoing relevance of older lens designs.

A claim is unpatentable under 35 U.S.C. § 103(a) if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious to a person of ordinary skill in the art **at the time the invention was made**. *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). Patent Owner's argument that a POSITA would not have been motivated to combine Kawamura and Golan should be rejected, because it is incorrectly based on alleged technology in 1981, instead of evaluation by a POSITA at the time the invention was made as required by *KSR*.

For example, Patent Owner argues that "a POSITA in 2009 or in 2013 would not expect the Kawamura lens to be successful if scaled down for use in Golan," because "in 1981 [] the computer simulation abilities to study and reduce lens sensitivity were limited." Response, 38; *see also* Response, 28-29 (discussing lower computer ability to optimize a lens design and more limited lens fabrication technology in 1981); Response, 40 (discussing that the use of aspheric surfaces

was not easily achieved in 1981). Patent Owner's own expert reaffirmed during deposition his reliance on limitations of computer-assisted lens design optimization and lens fabrication technology in 1981 as reasons why POSITA would not have been motivated to use Kawamura's design in Golan. APPL-1017, 70:18-71:12.

In addition, Patent Owner argues that in 2013, a POSITA "simply would not have looked" to Kawamura's 1981 design. First, Patent Owner argues that there were many developments in miniature lens design during those thirty years. Response at 39. But as explained above, Golan is not limited to miniature lenses. Second, Patent Owner appears to imply that designs from 1981 would be wholly outdated by 2013. However, lens designs remain relevant designs to a POSITA for many decades. APPL-1013, ¶39; APPL-1025, Smith 2005, 359-366 (Textbook titled "Modern Lens Design" from 2005 including example telephoto lens designs from 1950, 1977, and 1982). Indeed, Patent Owner's U.S. Patent 9,568,712 included claims for a lens design it believed was novel and non-obvious that were invalidated as anticipated by a 1968 patent. IPR2018-01146, Paper 37, 29-37.

Because Patent Owner incorrectly relies on an POSITA's knowledge of the technology in 1981, fails to consider the ongoing relevance of older lens designs with modern lens design, and fails to evaluate prior art as a POSITA at the time the invention was made as required by *KSR*, its argument that a POSITA would not have been motivated to combine Kawamura and Golan should be rejected.

D. Lens design software analysis supports the Golan and Kawamura combination.

1. Patent Owner fails to provide any optics design software analysis to support his opinion, which a POSITA at the time of the invention would have performed to evaluate prior art.

A POSITA, when evaluating Golan and Kawamura in 2013, the priority date of the '408 Patent, would have performed lens design software analysis and formed its opinion based on the lens design software. APPL-1013, ¶38. Petitioner and its expert have provided detailed lens design software analysis, which confirms the viability of Kawamura's lens design in Golan and reinforces the Petition's motivation to use same. Petition, 43-44; APPL-1003, ¶106, Appendix; APPL-1013, ¶40, Appendix.

2. To the extent that Golan is limited to miniature camera using miniature lenses, modifications or adjustments would have been within the level of a POSITA to accommodate the teachings of Kawamura in the system of Golan.

As discussed at III.B.3, Patent Owner's list of miniature telephoto lens requirements for a telephoto lens in Golan should be rejected. However, even to the extent that scaling by a large factor and/or miniature lenses were required in a combination of Golan and Kawamura, as Dr. Sasián testified with detailed analysis using lens design software ZEMAX, modifications or adjustments would have been within the level of a POSITA to accommodate the teachings of Kawamura in the system of Golan. APPL-1013, ¶¶41-49, Appendix.B; APPL-1023, Bates

(explaining steps for designing a miniature camera from a conventional lens design); APPL-1009, 56, 74-75, 203-204, 231, 254-355, 471, 587 (describing performing optimization and modification of lens parameters using ZEMAX). Because these modifications or adjustments were within the skill of a POSITA, they would not have dissuaded a POSITA from making the combination. APPL-1013, ¶42.

VI. Claim 6 is Obvious over Golan in Combination with Kawamura.

Patent Owner's argument that Golan does not disclose "*smooth transition*" is based on (1) an explicitly imported limitation of "no jump in the ROI region" in its proposed construction of "smooth transition," and (2) an implicitly imported limitation of "address[ing] the jumps of different sizes…as a result parallax." Response, 51. Both of these requirements are extraneous and incorrect, and should be rejected.

Patent Owner does not otherwise dispute that Golan discloses claim 6, and does not dispute that Golan discloses claim 6 under either Petitioner's proposed construction or the construction adopted by the Institution Decision. Response, 51-53.

III. A POSITA WOULD NOT HAVE BEEN MOTIVATED TO COMBINE GOLAN WITH KAWAMURA

Golan is directed to "light weight electronic zoom" (Ex. 1005, Golan at ¶¶ [0008], [0009]) and teaches away from the use of "heavy" lenses (*id.* at [0007]). As Apple's expert acknowledged, there is no standard definition of "lightweight" in the field of camera design. (Ex. 2015, Sasián Depo. Tr. at 122:4–11.) Rather, the question of whether something is lightweight is a "relative" question, which depends on the "application" and on what other designs are available for use in that application. (*Id.* at 122:4–18.) In applying the teachings of Golan for achieving a "lightweight" zoom, a POSITA would consider what Golan suggested as suitable sensors and lenses and would see Golan as pointing away from designs that are wildly heavier than Golan's examples.

A. Golan Plainly Teaches the Use of Lenses Much Smaller and Lighter than Kawamura's Lens

As Dr. Sasián stated in his deposition, a POSITA seeing that Golan referred to a 5 megapixel sensor would understand it to be describing a sensor with half-diagonal of 3 millimeters, i.e., a sensor diagonal of 6 millimeters. (Ex. 2005, Sasián Depo. Tr. at 47:10–48:5; *see also* Ex. 2003, Moore Decl., ¶ 54.) Dr. Sasián's reply declaration purports to calculate the weight of a lens

The fact that a POSITA would understand Golan to be teaching the use of miniature cameras is further supported by how NextVision itself describes its products, such as the 99-gram MicroCam-D. As Dr. Sasián testified, the NextVision website describes the company's "Vast Experience" by saying that "NextVisino has over ten years of experience as a company designing, manufacturing, and selling ***90–500 grams miniature cameras*** . . . ." (Ex. 2015, Sasián Decl. at 100:13–103:2 (emphasis added).) At least in the eyes of NextVision, its MicroCam-D and similar cameras are "miniature cameras."

Apple argues that Golan does not "require" a 5 megapixel sensor or a 1/4- or 1/3-inch sensor. This is true. Nothing in Corephotonics' arguments rests specifically on a sensor needing to have exactly those properties or on the camera meeting some particular definition of "miniature" cameras. But the fact that a 5-megapixel sensor is the only example of a sensor provided by Golan, and that both experts agree that such a sensor would have been understood to have had a particular size, is highly relevant in understanding what Golan means when it says "light weight" and how a POSITA would have understood its teachings. While the 5-megapixel sensor is not a hard requirement of Golan, it provides a yardstick by which to judge whether a lens is consistent

with Golan's teachings of a light-weight zoom and to understand that Kawamura's lens is heavier than what Golan contemplates by a factor of more than one hundred. (Ex. 1013, Sasián Decl., ¶ 30.)

Apple also suggests that the mere fact that Kawamura's lens lacks optical zoom makes it "light weight" and argues this is true by comparing its weight to the 4.58 kg "Fujinon A36X14.5 lens." (Paper 18, Reply at 12–13.) But this comparison of the 4.58 kg Fujinon lens to the 252 gram Kawamura lens overlooks the different intended uses of the two lenses. The Fujinon lens is a "Broadcast ENG" (Electronic News Gathering) camera with a long maximum focal length of 520 mm to permit long-distance shots. (Ex. 1027 at 1.) As Dr. Sasián testified, the mass of a lens "scales as the cube of the relevant linear dimension," so to scale the 200 mm focal length Kawamura lens to have the same magnifying power as the Fujinon lens would increase the mass of the Kawamura lens by a factor of 17.576, to a mass of "about 4.43 kilograms." (Ex. 2015, Sasián Depo. at 85:16–87:4.) In other words, on an apples-to-apples comparison, taking into account the different in magnifying power between the lenses, the Kawamura design yields a lens almost as heavy as the "heavy and expensive" Fujinon lens. Adding a second wide-FOV lens to Kawamura to practice Golan's invention by provide the same maximum focal

length as the Fujinon lens would plainly yield a system heavier than Fujinon's 4.58 kg. While there are many lenses in the world heavier than Kawamura's lenses, they are not suitable for providing a "light weight electronic zoom," as taught by Golan.

B. Apple Has No Response to Dr. Moore's Opinions and Dr. Sasián's Own Textbooks and Papers Showing that a POSITA Would Not Have Scaled Kawamura as Apple Suggests

A POSITA reading Golan would have understood that its invention requires a lens with a focal length far smaller than the 200 mm of Kawamura's lens. Whether the lens would be smaller by a factor of 14x to 20x, as Dr. Moore opines (Ex. 2003, Moore Decl. ¶ 77), by a factor of 10x, as Dr. Sasián estimated during his deposition (Ex. 2005, Sasián Depo. Tr. at 47:24–48:3), or by a factor of 6.4x as Dr. Sasián's new declaration suggests (Ex. 1013, Sasián Reply Decl., Appendix A), using Kawamura's lens design in Golan's invention by scaling it (as proposed in the petition, Paper 2 at 22–23) would have required a significant degree of scaling.

Dr. Moore provided an extensive analysis, based in part upon the textbooks and papers of Dr. Sasián and his students, showing that scaling by large factors is not done in practice, and that actual designs for small lenses from

Golan and Kawamura Are Directed to Completely Different Systems

! Golan is directed to miniature camera system for digital sensors
! Kawamura is a conventional camera lens for “medium format” film camera

POR 16–27; SR 5–6

Golan Is Directed to Miniature Camera System

- Golan teaches using two fixed field of view cameras to do digital zoom because mechanical zoom camera too big, heavy
  - Need for static, light weight electronic zoom (Ex. 1005, ¶ 8)
  - Example sensor – 5 megapixels (Ex. 1005, ¶ 8)

POR 16–20, 32–33; SR 5–10; Ex. 2003 ¶¶ 54, 74–75

Golan is Directed to Miniature Camera Systems

less electronic zoom range. For example, having a 5 Mega-pixel, 2592×1944, image sensor array and an output resolution frame of 400×300 yields maximal lossless electronic zoom of 6.48:

Ex. 1005, ¶ [0004]; POR at 19

A POSITA Would Not Have Looked to Kawamura as a Starting Point for a Lens to Combine with Golan

Prof. Duncan Moore
Patent Owner's Expert

87. A POSITA in or around 2013 simply would not have looked to a 200-mm lens designed in 1981 in selecting a design for Golan's narrow lens. Rather, the POSITA would look to designs that were purpose-made for miniature cameras and that took advantage of [thirty] years of technological improvement. As Dr. Sasián explains in his textbook, evolutionary development from existing miniature lens designs is the standard approach in the field: "[m]obile phone lenses have been evolutionary, in that every generation increased complexity from the previous one." (Ex. 2006, Sasián at 190.)

Ex. 2003, ¶ 87, POR at 39

core | photonics

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

A POSITA Would Not Have Looked to Kawamura as a Starting Point for a Lens to Combine with Golan

Prof. Duncan Moore
Patent Owner's Expert

There was also no shortage of miniature lens designs for a POSITA to use or to improve on: "[t]he patent literature has hundreds of lens design examples for mobile phone lenses and their forerunners, personal digital assistants." (Ex. 2006, Sasián at 190.) A POSITA would not have been motivated to go beyond rich literature of miniature lens designs and try scaling old lenses, designed for different purposes, with little reason to expect the result would be manufacturable.

Ex. 2003, ¶ 87, POR at 39

POSITA Would Not Combine Kawamura with Golan Without Improper Hindsight

Kawamura	Golan
Large conventional lens (larger than optical zoom lens available in 2013)	Directed to miniature cameras
From 1981 – 30-year-old lens technology	Miniature lens – different evolutionary path
6 cm x 7 cm film	5 megapixel digital sensor
Glass, spheric, aperture stop in middle, F# 4.1	Would use plastic, aspheric, aperture stop in front, F# 2–3

POR at 40–51

POSITA Would Not Combine Kawamura with Golan Without Improper Hindsight

Golan	Kawamura
Directed to miniature cameras	Large conventional lens (larger than optical zoom lens available in 2013)
Miniature lens – different evolutionary path	From 1981 – 30-year-old lens technology
5 megapixel digital sensor	6 cm x 7 cm film (200 – 400x larger!)
Would use plastic, aspheric, aperture stop in front, F# 2–3	Glass, spheric, aperture stop in middle, F# 4.1

POR at 40–51

telephoto lens. It has particular requirements. That the lens, the second lens have five lens elements, that those lens elements have specific configurations and properties, and that – those are clearly not taught by Golan, and they're only taught in Kawamura. Now, those lens elements are what Petitioner relies on from Kawamura. But there's nothing about those lens elements that would drive – that they point to in their motivation to combine to point you to Kawamura specifically. So, that's Claim 5.

Let's go to our Slide 5. And this goes to your point, Judge Anderson, and at the tail end, Golan and Kawamura are directed to completely different systems. Golan is a digital camera system where it uses fixed focal length lenses to use electronic zoom, which is not as good as optical zoom, as an approximation where optical zoom where you can't use optical zoom because the lens would be too big or heavy for that application. Kawamura, on the other hand, is aimed at film, and not just film, this is 1981, 30 years ago, it was medium format film. So, this is much larger than even standard 35-millimeter film. This is a big, medium format film camera lens from 1981.

So, now we're going to go to why there would be no motivation to combine, and I'll talk briefly what Golan first, and I think this will address Judge Ullagaddi's questions, I hope. So, if we can go to our Slide 9. So, Golan really is directed to a miniature, smaller camera system. And I don't want to get hung up on what miniature means. We're not saying it has to be mobile. What we know is that it's using two fixed focal length cameras to use electronic zoom to approximate optical zoom where optical zoom and optical zoom lens would be too heavy or big. So, that may differ on the

application, I agree, but if you've got an optical lens, that's better than using two different ones and it comes at a cost of resolution.

So, Golan teaches specifically that you need a lightweight electronic zoom, and the example that's given, and it is an example, is five megapixels, but that's in the context of a teaching that uses a digital system, and that five megapixel example is the only example and five megapixels is characteristic of miniature systems, which all fit with the whole point of Kawamura – of Golan. The whole point of Golan is to use approximate -- to use electronic zoom to approximate -- optical zoom where you can't have optical zoom. Optical zoom is better. It doesn't give you a loss of resolution. Optical zoom is better, but under some circumstances, those lens would be too big or heavy, according to Golan, and then this is a good substitute to use two different lenses and electronic zoom to approximate.

So, that's how we know that Golan is aimed at systems where a mechanical zoom lens would be too big or heavy. And that is the only motivation to combine. In response to your questions throughout the petition, the only motivation to combine with Kawamura specially is Golan saying we need something lightweight, and Kawamura saying back in 1981, this was lightweight.

And Judge Ullagaddi, your question is right on, which is, in 198 -- the fact that it was lightweight in 1981, doesn't mean it's lightweight now. And as I take you through the argument and our slides, I'll show you that the record evidence shows that lens technology is evolutionary, that there have been 30 years since Kawamura, of lenses getting lighter and better and that in 2013 at the time of this proposed combination, a lightweight lens would have particular characteristics. They would be plastic, they would have

aspheric lenses, and they would have an aperture stop at the front. All of those are contrary and different Kawamura. So, not only is Kawamura from 30 years ago and only says that it's lightweight 30 years ago, but it has none of the characteristic that one of skill in the art of 2013 would look to for a lightweight lens. And that's why this proposed combination has no motivation to combine with Kawamura specifically, except to get to those specific limitations in Claim 5 about those five lens elements.

So, let's go to -- we can go to Slide 11. So, this is from Dr. Moore's declaration, and this shows a relevant in time chart showing the relative kinds of sensors. And what it shows is that at the top you have miniature camera modules and the megapixel, which is the one, two, three, four, five, sixth column, three to five and five to eight, so five megapixels is the example, those are both characteristic, one of skill in the art would know, of miniature camera systems. Not even digital camera systems, but specifically miniature camera systems, as compared to the film camera system that Kawamura relates to which was large format.

And under film cameras, it has various sizes, there's 35-millimeter, 6x6 and you'll recall that Kawamura was actually a medium format 6x7 centimeter film format. And you'll see, in the next coming slides, that that's 400 times larger than the five-megapixel sensor. So, not only does the example tell one of skill in the art that Golan is applicable to miniature camera systems, but that makes sense with the whole purpose of Golan. If it's not a miniature system, and you have room for a big lens, you would just use an optical lens. You only use it where you can't have an optical zoom lens and that's only in miniature camera systems. So, now if we go to – so, now let's go ahead to Kawamura, so, Slide 16. So, this is where --

JUDGE ULLAGADDI: Counsel, before you move on to Kawamura, I have a question on Golan.

MR. FENSTER: Sure. Yes.

JUDGE ULLAGADDI: Why wouldn't a person of ordinary skill in the art consider Golan's teachings to be applicable to both miniature cameras and large-scale cameras?

MR. FENSTER: Okay. So, it would be -- so, the answer is two-fold. One, Golan could be used in any system, miniature or otherwise, where the optical zoom is not available. You would only use it a poor substitute as an approximation for an optical zoom in a system where an optical zoom lens is not available. And the record evidence has developed that there were mechanical zoom lenses smaller than Kawamura by 2013. So, it's not -- you could use it in a larger system, but the reason why you wouldn't is it's an approximation of optical zoom, you lose resolution by doing electronic zoom as opposed to it, you have to have two lenses instead of one, and so there's the only reason to do it would be if an optical zoom is not available.

So, it's not that it has to be limited to mobile systems specifically, but it does teach that it's limited to systems or one of skilled in the art would understand that you would only use it where an optical zoom is not available. It's complicated. You have to have two systems, two cameras to approximate zoom, so instead of having one lens, you're using two, you're having to do some kind of processing to combine the images and you lose resolution in doing so. So, one skilled in the art would know all those things and that the only reason to do it would be when the optical system is not available and that in combination with the examples that they provide would confirm that one of skill in the art would be looking to a miniature system.

So, it's not that you couldn't, it's that you wouldn't and there wouldn't be any motivation to do so.

JUDGE MOORE: This is Judge Moore. Patent Owner -- I mean, Petitioner, excuse me -- pointed to the assignee of Golan and said that they had a product was a camera on a drone. They also pointed to other patents by the same assignee. What is your response to that and how should we deal with those things?

MR. FENSTER: Yeah, so that's a great question. So, thank you, Judge Moore. The other patents -- none of the other patents that Petitioner cites to from NextVision, the Assignee of that patent or the drone patents, none of those use the Golan two camera system, the invention of the Golan. They just happen to be by the same assignee, but all of those NextVision cameras were not two camera systems, they were specifically one camera system, which would teach away, if anything, but they certainly don't prove Petitioner's point. If anything, they go the other way. So, the NextVision systems that Petitioner cites to, none of those are two camera systems. There's no record evidence that those are two camera systems where one with different fixed focal planes with different field of views.

So, yeah, that's the main point that they're pointing at something that just because it's an assignee to say this was a bigger camera, but it has nothing to do with the Golan primary reference of a two-camera system to approximate electronic zoom. If it was, you would think that the assignee of the Golan system would have used that system in those NextVision products. And the fact that they didn't, I think tells you more, you know, tells you something about the fact that one of skill in the art wouldn't have

JUDGE ANDERSON: Mr. Fenster, before you go on, just one quick question. There is no dispute that if you were -- if you were, if a person were skilled in the art, did combine Golan -- I'm going to mess up the Y name, the yellow, the Y reference -- that all of the elements of Claim 5 are shown by that combination; correct?

MR. FENSTER: You're correct, Judge Anderson. We do acknowledge that for Claim 5 only, Golan does teach the elements that I showed in green, and Kawamura does have the elements in blue, and our argument with respect to Claim 5, is there's no motivation to combine the two. And with respect to Claim 6, of course, we dispute that Golan teaches smooth transition and we'll get there later.

So, Golan, you know, really is aimed at a smaller system where you use two fixed cameras to approximate zoom where you can't use an optical zoom camera. Kawamura is much larger. If we go to our Slide 16, you'll see the screen size of 6x7 that's the film that it's talking about, six centimeters by seven centimeters. Our Slide 17 shows how big Kawamura is. This is over seven inches, half a pound, this is a big camera system particularly by 2013 standards. And by 2013, the record evidence is that there were mechanical zoom cameras for that were much smaller than Kawamura. The -- Slide 18, our Slide 18 just shows you that five megapixel camera the sensor is 400 times smaller than the film sensor of Kawamura that's also on our Slide 19.

So, these are just vastly different systems that you're looking at. It's also much heavier, our Slide 20, shows that it's 500 times heavier than a scaled down version of Kawamura would be for the five sensors. And the

with a gap between four and five being the largest gap. There's nothing that they point to as motivation to say you would go to Kawamura which has those particular requirements. And out of the thousands of telephoto lenses that have, that exist in the prior art, the only one that they point to as meeting those requirements, is Kawamura. So, what leads you to Kawamura specifically other than impermissible hindsight where you're looking to meet the elements of Claim 5. I submit to Your Honors, that there's no answer to that, except for impermissible hindsight.

At best, all they show is that there's a motivation to combine Golan with a lightweight telephoto lens in 2013. That alone would get you combination with hundreds or thousands of lightweight lenses in 2013, let alone going back to this one to pluck out of the sea of prior art and say that this is the one that one skilled in the art would be motivated to pick out and here's why.

JUDGE ULLAGADDI: I have a question before you move on.

MR. FENSTER: Sure.

JUDGE ULLAGADDI: I think I heard you say that Golan could be applicable to various ranges of sizes of camera and if that's true, and Kawamura doesn't have to be scaled, then what's to preclude this combination?

MR. FENSTER: Yeah, so, the point is, I think one of skill in the art would understand Golan to be useful in systems where you can't -- where an optical lens is not available because it's too big or heavy. So, it's, you know, absent evidence that you don't that one is skilled in the art in 2013 wouldn't have a mechanical zoom lens at the same size or smaller than Kawamura in 2013, there's no reason to go to Kawamura specifically. There were

Good cause exists to admit APPL-1036, a brief Patent Owner (PO) submitted, on August 2, 2021, in a Korean Supreme Court appeal from an IPTAB proceeding ("Korean Brief").[1] Good cause exists because: (1) PO admitted in the Korean Brief that its core argument in this proceeding, on which the Board ultimately relied in its FWD, is wrong; and (2) Apple could not have presented this admission previously.[2]

First, good cause exists because PO's admission to the Korean tribunal directly contradicts the representations PO made to this one, and this tribunal was thereby misled into finding in PO's favor based on those misrepresentations. Here, PO told the Board that, in 2013, there was "no shortage of miniature lens designs" and, thus, a POSITA would have looked to "***rich literature***" of miniature telephoto designs, rather than to Kawamura. *See* POR, 39; H'rg Tr., 29:21-24; Sur-Reply, 14. The Board relied on that premise to find that "[a] POSITA would not have been motivated to go beyond [the] ***rich literature of miniature lens designs*** and try scaling old lenses." FWD, 36 (quoting Ex. 2003, ¶87). PO and its expert failed to

---

[1] *See Huawei Device Co. v. Optis Cellular Tech.*, IPR2018-00816, Paper 19 at 4 (PTAB Jan. 8, 2019) (precedential) ("good cause" standard for new evidence on rehearing). Even the "interest of justice" standard is met here. 37 C.F.R. § 42.123(b).

[2] The Board denied Apple's request for a conference call to address good cause for this and other evidence, permitting Apple these two pages only for the Korean Brief.

identify any miniature telephoto lens design out of its alleged "rich literature," so the Board relied solely on PO's misrepresentation. But days after the FWD, Corephotonics admitted to the Korean tribunal that "there were ***hardly any*** telephoto lens assemblies applied to portable terminals" in 2013. APPL-1036, 2; *id.*; *id.*, 7 (in 2013, "a [POSITA] did not think that the telephoto lens assembly could be installed in the portable terminal"); *id.*, 2 (in 2013, "there was ***only one*** prior document that mounted the telephoto lens assembly on a portable terminal"). PO should not be permitted to rely on a factual misrepresentation here to secure a favorable result while maintaining the opposite before another tribunal. The Board therefore should admit and consider the Korean Brief on rehearing. *See Ultratec*, 872 F.3d at 1271–75 (abuse of discretion where Board refused to admit and consider conflicting evidence); *cf. Paice LLC v. Toyota Motor Corp.*, 504 F.3d 1293, 1312 (Fed. Cir. 2007) (counsel statements weighed as evidentiary admissions).

Second, good cause exists because this new evidence could not have been presented earlier, as PO waited until after the FWD before making its contrary admission in Korea. The Board has found "good cause" in similar circumstances. *See Unified Patents v. MV3 Partners*, IPR2019-00474, Paper 16 at 1-4 (PTAB Aug. 5, 2019) (admitting transcript as new evidence on rehearing where hearing occurred after the Board's decision); *cf. Ultratec, Inc. v. CaptionCall, LLC*, 872 F.3d 1267, 1272 (Fed. Cir. 2017) ("inconsistent testimony did not exist sooner").

length of Kawamura, and a "***rich literature of miniature lens designs***").

The Board adopted Dr. Moore's conclusory opinion and mischaracterized as impeachment a 2015 statement from Reshidko & Sasian. Compare Ex. 2008, 1 ("traditional objective lens cannot be *simply* scaled down") with Decision 36-37 (characterizing the statement as "POSITA would have been dissuaded"). The Board ignored well-known modifications other than scaling, and ignored Dr. Sasian's detailed testimony (including lens design software analysis) regarding how a POSITA would have modified Kawamura, *not simply/only scaled* it, to smaller sizes. *See* Reply, 22-23; APPL-1013, ¶¶28-33, Appendix B-ZEMAX analysis, ¶¶40-49 (explaining POSITA knowledge). The Board also erred in concluding that "Petitioner's contention of predictable results is too generic," without analyzing Petitioner's detailed explanation. Pet., 22-23; (APPL-1006), 57; (APPL-1009), 254-355; APPL-1003, ¶¶63-64; APPL-1013, ¶¶29-33, Appendix.

2. The Decision misapplied the law of obviousness under KSR.

As shown in FIGs. 1B, 1D below, the Board errantly required bodily incorporation of Kawamura's exemplary 200mm focal length lens into Golan's system with an exemplary "5 megapixel image sensor array." *See, e.g.*, FWD, 34, 39 (Golan not understood to refer to "a larger-scale imaging system capable of ***accommodating a lens assembly of the size*** disclosed in Kawamura."). This is clear error. *In re Mouttet*, 686 F.3d 1322, 1332 (Fed. Cir. 2012) ("test for obviousness is

not whether the features of a secondary reference may be bodily incorporated into the structure of the primary reference"). The Board ignored that modifications (including but not limited to scaling), were within a POSITA's skill. Reply, 22-23; APPL-1013, ¶¶28-33, Appendix B-ZEMAX analysis, ¶¶40-49.

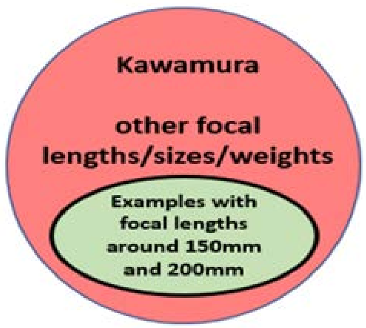


FIG. 1B: Board's Incorrect Scope with Exclusion (red)

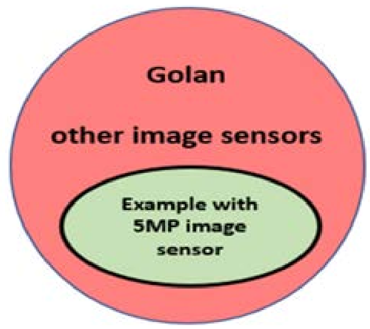


FIG. 1D: Board's Incorrect Scope with Exclusion (red)

Finally, the Decision incorrectly required conclusory proof of "a finite number of identified, predictable solutions," which is not necessary to show obviousness. FWD, 38 (discussing a requirement that "a POSITA would have understood that there were ***only a few options*** for telephoto lens design"). This is clear error, because "obvious to try" is only one of the rationales that may support a conclusion of obviousness. *See*, *KSR*, 550 U.S. at 1742; MPEP 2141, 2143.

III. CONCLUSION

For the foregoing reasons, the Board should grant rehearing and determine Challenged Claims of the '408 patent unpatentable.

Respectfully submitted,

/David W. O'Brien/
David W. O'Brien, Reg. No. 40,107

MultiLing
A Questel Company

TRANSLATOR'S CERTIFICATE OF TRANSLATION

Translation from: Korean to English
MultiLing Project Number: RENOO2130026HQ (2021.08.02. 상대방 참고서면)
Client: Haynes and Boone, LLP

MultiLing Corporation, a Delaware corporation, with its principal office at 180 North University Avenue, Suite 600, Provo, UT 84601-4474, USA, certifies that:

a) it is a professional translation company of multiple languages, including Korean and English;
b) it has translated from the original document to the translated document identified below, and to the best of its knowledge, information, and belief the translation of that document is accurate as a publication quality translation; and further,
c) these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Original Document Identifier: 2021.08.02. 상대방 참고서면.pdf

Translated Document Identifier: 2021.08.02. 상대방 참고서면_en-US.docx

Signed this 13th day of August, 2021.

Joseph Haymore
Program Manager

ACKNOWLEDGMENT BEFORE NOTARY

State of Utah
§
County of Utah

On this 13th day of August, in the year 20219, before me (Stephanie Haymore), a notary public, personally appeared Joseph Haymore, proved on the basis of satisfactory evidence to be the person whose name is subscribed to this Translator's Certificate of Translation, and acknowledged that he or she executed the same..

IN WITNESS WHEREOF, I hereunto set my hand and official seal.

STEPHANIE ANN HAYMORE
NOTARY PUBLIC • STATE OF UTAH
COMMISSION# 712174
COMM. EXP. 05-21-2024

Notary Public, residing at Orem, UT

Written Submission

Case **2020Heo6323 Registration Invalidation (Patent)**

Plaintiff **Corephotonics Ltd.**

Defendant **LG Innotek**

Regarding the above case, the **Plaintiff's attorney** hereby submits Written Response with arguments to the Defendant's Briefs dated February 8, 2021 and May 28, 2021 as below.

Below

1. Gist of Defendant's claim and its unjustness

The Defendant stated in the Brief dated May 28, 2021 that the corrected subject invention: ① fails to meet the requirement for the supporting description and the requirement for the description to enable one to easily embody the invention; ② fails to meet the requirement for clear and concise description of the claims; and ③ includes a reason for invalidation on new matter ground.

In addition, the Defendant stated again in the Brief dated February 8, 2021 that: ④ the corrected subject invention loses inventive step in view of Reference 1 alone or Reference 1 combined with the known technology (or Prior Art in Exhibit No. Eul-5,6); and ⑤ the corrected subject invention is the same as Reference 2 and thus has a reason for invalidation on the ground of the violation of enlarged concept of novelty, because its application date is not retroactive to the priority date.

However, the Defendant's allegations are without merit.

Hereinafter, we will provide supplementary explanations to the questions asked by the board at the hearing date on June 10, 2021, and then explain in detail how the Defendant's allegations are unjust.

2. Supplementary explanation to the questions of the board on the date of hearing on June 10, 2021

A. Cameras that were applied to portable terminals at the time of filing the application of the invention of the subject patent

The invention of the subject patent is the original technology for the telephoto lens assembly mounted on a portable terminal and is widely used until now.

At the time of filing the application of the invention of the subject patent (around 2013), there was only one prior document that mounted the telephoto lens assembly on a portable terminal,[1] and most of the camera manufacturers for portable terminals were trying to develop 'wide-angle lens assembly' rather than 'telephoto lens assembly'.[2]

In paragraphs [0004] and [0005] of the specification of the subject patent, it describes that conventional lens assemblies comprising four lens elements are no longer sufficient for good quality imaging in a compact imaging lens system, and that US8,395,851 (that is, wide-angle lens assembly) using five lens elements suffers from the problem that the ratio between TTL and EFL is too large. This is because there were hardly any telephoto lens assemblies applied to portable terminals at the time the application of the invention of the subject patent was filed.

Registered Patent No. 10-1757101

Consumer demand for digital camera modules in host devices continues to grow. Cameras in cellphone devices in particular require a compact imaging lens system for good quality imaging and with a small total track length (TTL). Conventional lens assemblies comprising four lens elements are no longer sufficient for good quality imaging in such devices. The latest lens assembly designs, e.g. as in US 8,395,851, use five lens elements. However, the design in US 8,395,851 suffers from at least the fact that the ratio between TTL and an effective focal length (EFL) is too large.

[0005] Therefore, a need exists in the art for a five lens element optical lens assembly that can provide a small TTL/EFL ratio and better image quality than existing lens assemblies.

[Excerpt from the subject patent specification]

---

[1] Among the documents submitted by the Defendant, only one, that is, Reference 1 (Exhibit No. Eul-4) discloses the small telephoto lens assembly for portable terminals before the priority date of the invention of the subject patent. The Plaintiff has no additional information regarding this.

[2] The wide-angle cameras were applied to portable terminals in the late 1990s, and it was in the second half of 2017 when the telephoto cameras for portable terminals were actually applied. The fact that it took about 20 years until the telephoto camera were applied to portable terminal demonstrates the technical excellence of the invention of the subject patent.

In order to obtain sufficient image quality under the constrained environment of short total track length (TTL), the telephoto lens assembly applied to portable terminal required a new structure and shape different from those of the conventional telephoto lens assembly for general cameras.[3] To this end, the invention of the subject patent adopted a new structure that: ① has a short total track length (TTL≤6.5 mm); ② has a focal length (EFL) longer than the total track length; ③ has an increased refractive power of the first lens element (f1<TTL/2); and ④ has an F# of less than 2.9 (See page 2, Plaintiff's Written Submission dated November 25, 2020).

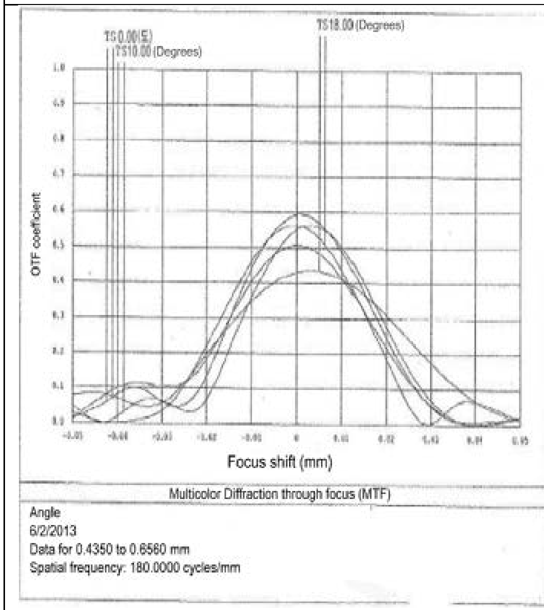
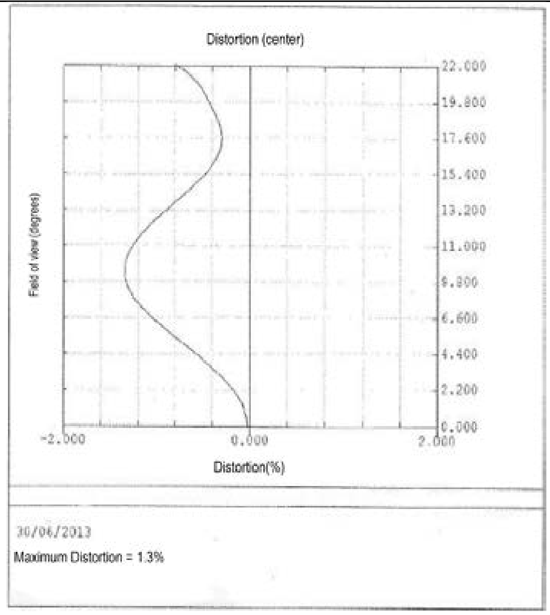
B. Relationship between the upper limit of TTL, the upper limit of F#, and the positive refractive power of the first lens element and TTL

Regarding the configuration of TTL < 6.5 mm, TTL/EFL ≤ 1, F# < 2.9, f1 < TTL/2, ① the 6.5 mm upper limit of TTL (related to TTL < 6.5 mm configuration) is related to the limit of the lens assembly according to the thickness of the portable terminal, ② the 2.9 upper limit of F# is related to the maximum incident light amount of the lens assembly, and ③ there is correlation such that TTL decreases as the positive refractive power of the first lens element increases.

However, in judging the inventive step, one should not look at whether or not each of the above configurations is individually disclosed in the prior art, but rather judge the inventive step on the basis of the overall invention in which each of the above configurations is organically combined.

In Claim 1 of the corrected subject invention, the configurations of TTL < 6.5 mm, TTL/EFL≤1, F# < 2.9, and f1 < TTL/2, and so on are **organically combined**, thus enabling a small telephoto lens assembly for portable terminal to obtain high image quality, and a high-quality image can be obtained, with a distortion error of the obtained image within 2% that is not perceptible to the human eye. This is also confirmed in the drawings of the subject patent, that is, in FIGS. 1b, 1c, 2b, 2c, 3b, 3c, and so on. FIGS. 1b and 1c are shown below as representative examples.

[3] If the telephoto lens assembly for a general camera is reduced as it is, the area of the image pickup device corresponding to the film becomes extremely narrow, and a good image cannot be obtained (See pages 19-20, Plaintiff's Written Submission dated May 25, 2021). This is also clearly stated in Exhibit No. Eul-6-1 which was submitted by the Defendant.

(FIG. 1b)	(FIG. 1c)
	
Each part of the sensor has the maximum modulus of the OTF[4] near the focal point (0 mm), so the image is clear	Showing up to 1.5% image distortion, which is less than 2% that is perceptible to the human eye

C. How low a person of ordinary skill in the art would currently consider the 'Lower limit of TTL' to be

As shown in the table below, at the time of the priority date of the invention of the subject patent (July 4, 2013), the lower limit of the thickness of the portable terminal was 6.5 mm or greater. Considering the development of the technology of parts for the operation of portable terminals and the number of lenses installed in the wide-angle and telephoto lens assemblies, the thickness of the current portable terminal (or the maximum lower limit of TTL) is estimated to be 4.5 mm to 5 mm.

[Table of thicknesses of portable terminals by portable terminal manufacturers at the time of priority date of the invention of the subject patent]

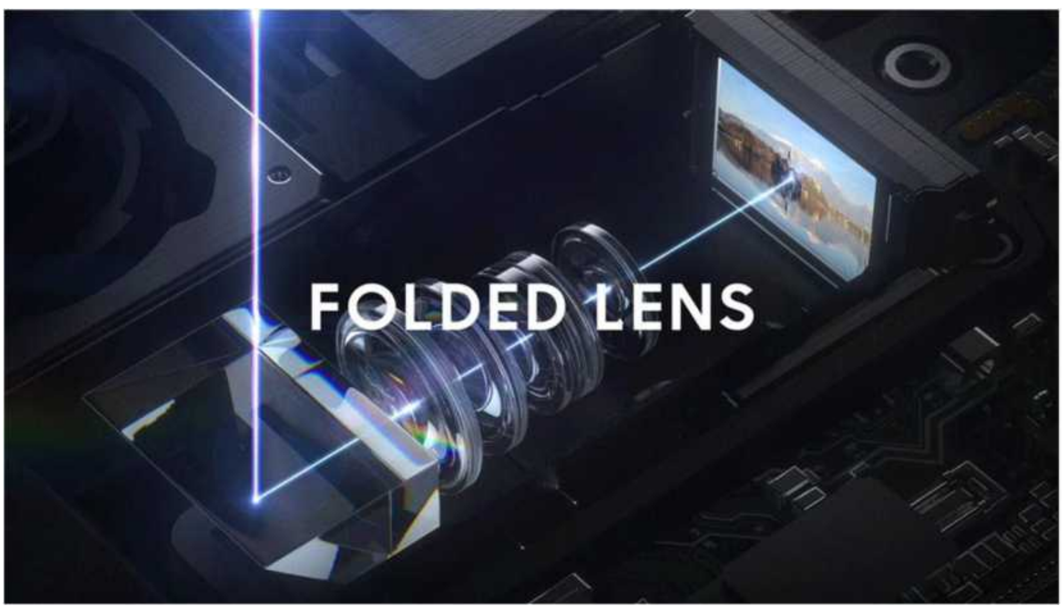
[4] OTF, which is the abbreviation of the optical transfer function, is the function that represents spatial frequency transmission capability of an optical system such as a lens, and it refers to a method of displaying resolution (Reference 1. Science Encyclopedia, search result screen for "response function")

Manufacturer	Model Name	Release Date	Smartphone Thickness	Remark
OPPO	X907	2012.06	6.65 mm	Reference 2
Fujitsu	Arrows ES IS12F	2012.01	6.7 mm	Reference 3
Huawei	Ascend Pls	2012.01	6.68 mm	Reference 4
Apple	iPhone 5	2012.09	7.6 mm	Reference 5
Samsung	Galaxy S4	2013.03	7.9 mm	Reference 6
SONY	Xperia Z Ultra	2013.06	6.5 mm	Reference 7

In recent years, technologies have been developed to overcome limitations due to the thickness of portable terminals by adopting a method of bending the lens arrangement direction at right angles from the thickness direction to the width direction of the portable terminal, or a method of increasing the number of cameras.

Reference 8. Samsung Homepage Folded Lens Screen

The lens requires additional space for its vertical structure, and this makes the camera thicker. However, since the folded lens uses a prism like the periscope principle, it can sit flat on the bottom of the smartphone camera. When the light entering through the back of the smartphone is transmitted to the lens by the prism, the folded lens having the lens structure horizontally aligned inside the phone refracts the light by 90 degrees to increase the focal length. In this way, the height and width of the camera are reduced, realizing the innovative zoom performance of the Galaxy S20 Ultra.



Considering the thickness of the portable terminal currently expected by those of ordinary skill in the art (4.5 mm to 5 mm as the lower limit of TTL), the judgment of the trial decision (or the allegation of the creditor) that "the detailed description of the subject patent is not described in

such a manner that enables one to easily embody the TTL close to zero (0.1 mm or less) and F# close to zero (10^{-3} or less)" is entirely meritless, as it assumes extreme cases that undermine the technical significance of the invention of the subject patent.[5]

D. Regarding how the numerical values of configurations of the 6.5 mm upper limit of TTL and the 2.9 upper limit of F# of Claim 1 of the corrected subject invention are set

A very important consideration for **the compact telephoto lens assembly mounted on the portable terminal** is the thickness (the length of TTL) of the compact portable terminal to which the telephoto lens assembly is mounted, which is different from the general lens assembly that has no particular restrictions on the length of the TTL. Another important consideration is whether the small telephoto lens assembly can provide a large amount of light to realize high-definition image, but this is not a problem for the conventional wide-angle lens assembly with a short focal length because it would not have a lack of amount of light. In other words, for the telephoto lens assembly mounted on a small portable terminal, the values of TTL and F# have technical significance at their upper limits.

At the time of filing the invention of the subject patent (around 2013), there was almost no technology for attaching the telephoto lens assembly to the portable terminal, and the inventors of the invention of the subject patent studied a compact telephoto lens assembly that can be mounted to the compact portable terminal and obtain high quality image and, as a result, arrived at the optimal upper limit of TTL and upper limit of F#.

The numerical range of TTL can be derived from the statement[6] "TTL is smaller than the EFL" in the Detailed Description of this patent and the TTL values of the Examples.

That is, in the embodiments where TTL < EFL and EFL = 6.90 mm (Embodiment 1), 7 mm (Embodiment 2), and 6.84 mm (Embodiment 3), sufficiently high-quality images were obtained at least at TTL < 7 mm. In addition, in the embodiments, it was confirmed that good images can still be obtained even with TTL=5.904 mm (Embodiment 1), 5.90 mm (Embodiment 2), and 5.904 mm (Embodiment 3) which are thinner, and then the upper limit of TTL was reduced to

[5] The Patent Court's Decision 2018 Heo 2700 on August 30, 2018 ruled that "it is not acceptable to assume the extreme cases that undermine the technical significance of the invention of the subject patent and require the description of the invention describe even those cases to the extent that they can be embodied".

[6] Exhibit No. Kap-3 paragraph [0009]

6.5 mm that is smaller than 7 mm so that a sufficiently good image can be obtained even when the elements are organically combined.[7]

Regarding F#, the condition of F#<2.9 is derived from the description "the lens assembly has an F number F#<3.2" (Exhibit No. Kap-3 paragraph [0009]) and from F# = 2.80 (Embodiment 1), 2.86 (Embodiment 2), and 2.80 (Embodiment 3) (as the embodiments for obtaining a sufficient amount of light to obtain good image quality in a compact telephoto lens assembly for a portable terminal where TTL is 6.5 mm or less and TTL/EFL is less than 1). Meanwhile, since the image sensor used in portable terminals has a size limitation, the upper limit of F# is limited to 2.9 that is smaller than 3.2 to ensure sufficient amount of light even when the number of pixels of the image sensor is increased[8] to enhance resolution under limited area conditions.

E. Whether it is a technical problem to make the TTL smaller and the F# smaller in light of the common sense in the technical field of lenses

Since the technical concept of the telephoto lens assembly for a portable terminal was different from the general telephoto camera in many ways, at the time of filing for the invention for the subject patent, a person of ordinary skill in the art did not think that the telephoto lens assembly could be installed in the portable terminal. Therefore, a person skilled in the art at the time was not even aware of the "technical problem of having a small TTL, while making TTL smaller than EFL and making F# smaller" as a technical problem to develope a telephoto lens assembly for a portable terminal.

Also, at the time of filing for the invention of the subject patent, the person of ordinary skill in the art was not able to anticipate that the telephoto lens assembly for a portable terminal, which "has a small TTL that allows installation in the portable terminal, while having the TTL smaller than EFL and having a smaller F#", can obtain good images as shown in FIGS. lb, 1c, 2b, 2c, 3b and 3c.

If one deems that "having a small TTL that allows installation in the portable terminal, while making TTL smaller than EFL and making F# smaller" is a general technical problem in this

[7] This indicates the fact that the invention of the subject patent is used for the portable terminals, and that it is such a telephoto lens assembly that, unlike the **typical telephoto camera**, is good to be mounted to a very thin terminal, that is, to the portable terminal with the thickness (6.5 mm or larger) at the time of priority date of the invention of the subject patent.

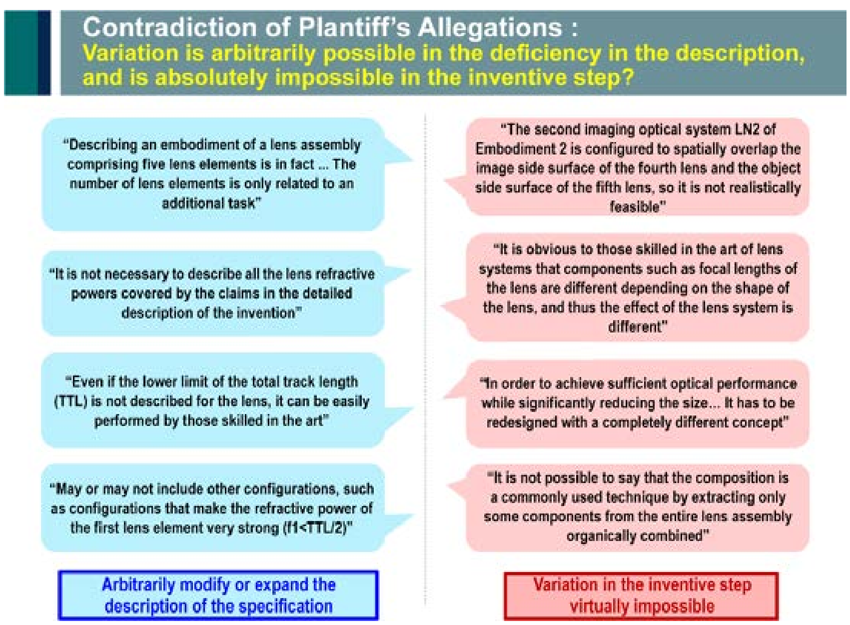
[8] Each pixel becomes smaller.

field based on the present time when the telephoto lens assemblies for portable terminals are generally used, this is a typical hindsight bias, since he judges so based on hindsight on the premise that a person skilled in the art is aware of the technology disclosed in the specification of the subject patent.

3. Refutation to Defendant's claim

A. There is no contradiction in the Plaintiff's arguments for the lack of description and the inventive step.

According to the Defendant, the Plaintiff made contradictory arguments by saying that, for the inventive step, a person skilled in the art cannot arbitrarily change the configuration of the lens assembly, whereas against the lack of description, the configuration of the lens assembly can be arbitrarily changed (see page 70, Defendant's argument dated June 10, 2021).



[page 70, Defendant's argument dated June 10, 2021]

However, the Defendant's allegation is without merit.

<u>**Enablement requirement (that is, lack of description)**</u> is a test to determine whether or not a person skilled in the art can easily embody the invention described in the claim <u>by referring to the description of the</u> <u>**specification of the patented invention and the level of technology at**</u>

<u>the time of filing</u>. Therefore, it is not technically difficult for a person skilled in the art to modify the rest of the lens configurations based on the core configuration proposed by the patented invention by referring to the technical level at the time of filing and the description of the specification of the subject patent.

On the other hand, **<u>whether there is difficulty of configuration (that is, inventive step)</u>** is a test to determine whether it is easy for <u>a person skilled in the art without knowledge of the configuration of the invention of the subject patent</u> to derive the configuration of the invention of the subject patent from the **<u>earlier inventions</u>** <u>at the time of filing.</u> Since there is a fundamental difference in the technical idea between the invention of the subject patent and the References, and since the specific configurations are also different, a person skilled in the art cannot derive all or part of the configuration of the invention of the subject patent from the References (or by modifying configurations of the References).

Therefore, the Plaintiff's argument is not contradictory at all.

B. The Defendant's assertion that the invention of the subject patent is not supported by the detailed description of the invention is without merit.

(1) The Defendant argues that since the refractive power combination (positive/negative/negative/positive/negative) of the five lens elements is specifically described in the detailed description of the subject patent, the configuration of the lens assembly of a different combination is not supported by the detailed description of the invention (Defendant's Brief dated May 28, 2021 pages 3 to 5).

However, all of the Defendants' above arguments are without merit.

(2) With regard to the number of lenses, the technical problem of the invention of the subject patent is not limited to the combination of the refractive power of the five lens elements, but is to provide a compact telephoto lens assembly for a portable terminal which is thin (with a smaller TTL/EFL ratio) and capable of obtaining good images (for details, see pages 3 to 17, Plaintiff's submission dated February 18, 2021).

The detailed description of the subject patent describes the need for a compact telephoto lens assembly capable of obtaining a good image with a thin thickness even when it exceeds four lens

elements (Exhibit No. Kap-3 paragraphs [0004], [0005]), and it does not necessarily limit to the optical lens assembly of five lens elements.

In addition, the subject patent simply states that the purpose of the patent is to provide a small telephoto lens assembly that can solve the conventional problems as the "problem to be solved", and it does not limit the number of lens elements (Exhibit No. Kap-3 paragraph [0006]).

Furthermore, since the invention of the subject patent describes an optical lens assembly comprising a 'fifth lens element' in the form of an open claim as an 'embodiment' (Exhibit No. Kap-3 paragraph [0007]), it does not limit the number of lens elements to five.

According to the Defendant's argument, all configurations of the lens assembly described as the embodiments in the detailed description of the invention should be described in the independent claim, but this is against the Enforcement Decree of the Patent Act[9] stipulating that the invention can be divided and entered as independent and dependent claims and the Supreme Court ruling that "the configuration described in the claims does not necessarily have to be described in the detailed description or drawings of the invention" (Supreme Court Decision[10] 2003Hu2072 on November 24, 2006).

We note the Defendant himself has also registered a number of patents based on the claims further specifying the invention described as an embodiment in the detailed description of the invention.[11]

(3) With regard to the refractive power combination, when considering the technical level at the time of filing of the invention of the subject patent and the description of the subject patent specification, details of 'a pair of second and third lens elements having negative optical power together' of the invention of Claim 35 of the subject case are either described in the detailed

[9] Article 5(1) of Patent Act Enforcement Decree

[10] "As long as the invention of the subject patent is described in such a manner that allows addition of other technologies to the elements explicitly described in the claims, although the detailed description or drawings of the embodiments of the inventions of Claims 17 to 22 of this case are expressed by adding a 'step of separating words and postpositions' which is not described in the claims, it should not be said that the inventions of Claims 17 to 22 mentioned above are not supported by the detailed description only under such circumstances."

[11] See Exhibit Nos. Kap-10 and 11, each of the registered patent publications, and pages 4 to 6 of the Plaintiff's Brief dated February 18, 2021.

description and drawings of the subject patent, or fully recognizable by those skilled in the art from the specification of the subject patent (Plaintiff's Brief dated February 18, 2021 pages 9 to 10).

Specifically, the detailed description of the subject patent states, "The relatively large distance between the third and the fourth lens elements plus the combined design of the fourth and fifth lens elements assist in bringing all fields' focal points to the image plane" (Exhibit No. Kap-3 paragraph [0011]) and "the focal length of the first lens element f1 with positive refractive power is smaller than TTL/2" (Exhibit No. Kap-3 paragraph [0009]).

This means that the light is refracted as it passes through the first lens element with positive refractive power (i.e., the converging lens) to be converged strongly at one point, and therefore, it has to travel relatively a long distance (a long distance between the third and fourth lens elements) until it passes through the fourth lens element.

That is, anyone skilled in the art can easily figure out that, in order for the light to travel a long distance between the third and fourth lens elements and arrive at the fourth lens element, **it is essential that the second lens element and the third lens element perform the function of a concave lens (negative refractive power) to spread light**.

Also, the fact that f2 of the second lens element and f3 of the third lens element may have a positive or negative value, respectively, correctly matches the description in the detailed description of the subject patent stating, "the minimal chromatic aberration are obtained by fulfilling the relationship 1.2x|f3| > |f2| > 1.5xfl", where the values are expressed as absolute numbers (Exhibit No. Kap-3 paragraph [0010]).

C. Even if the lower limit of the TTL and F# values are not specified in the claims, a person skilled in the art can embody the corrected subject invention.

The Defendant asserts that, without having the upper or lower limit of the numerical range set, a person skilled in the art cannot easily embody the invention described in the claims (Defendant's Brief dated May 28, 2021 pages 7 to 10).

However, the Defendant's above allegation is also without merit.

First of all, it can be assumed that a person skilled in the art in the subject case is “a person who has completed a master’s course in lens assembly technology and has about 2 to 3 years of industry experience”.

The Defendant's assertion that a person skilled in the art cannot embody the invention of the relevant lens assembly just because the lower limit of TTL or F# is not stated seems far-fetched.

As described above, the technical significance of the invention of the subject patent lies in the upper limit of TTL and F#, and for the lower limit of TTL and the lower limit of F#, a person skilled in the art can easily set as needed by considering physical limitations such as thickness and amount of light of the portable terminal.

Therefore, as long as the technically important numerical value of the upper limit is specified, a person skilled in the art can of course practice the invention of the subject patent.[12]

The similar cases from the patent offices in many other countries also agree that it is possible to embody the invention even when the configuration of the lower limit of TTL or F# is not described in the claims (Exhibit Nos. Kap-9, 28 to 34).

If it is required to list all the possible numerical ranges as argued by the Defendant, it will lead to an unfair conclusion that the inventor should perform a number of unnecessary experiments to find meaningless lower limits.[13]

D. The numerical ranges of TTL or F# of the invention of the subject patent are supported by the detailed description of the invention.

The Defendant asserts that the invention of the subject patent fails to specify the lower limits of the numerical range of TTL (TTL $\leq$ 6.5 mm) and the numerical range of F# (F# $<$ 2.9), and therefore, fails to meet the description requirement for the lack of support (Defendant's Brief dated May 28, 2021 page 6).

However, the Defendant’s above allegation is also without merit.

[12] Patent Court Decision 2012Heo6700 on January 25, 2013 also ruled that it would be sufficient to specify only the upper limit or lower limit of the technically important numerical value, and it should not be said that the invention is unclear just because the technically insignificant lower limit or upper limit is not specified.

[13] In fact, it may not even be possible to ascertain whether there is any critical significance at the lower limit of such (meaningless) figures.

The Supreme Court consistently ruled that "whether a claim is supported by the detailed description of the invention should be judged by whether or not the matters corresponding to the matters described in the claims are described in the detailed description of the invention from the standpoint of those skilled in the art." (Supreme Court Decision 2012Hu832 on September 4, 2014).

A person skilled in the art designing a lens system for a portable terminal will immediately recognize from the upper limit of the TTL that the invention of the subject patent is applied to a small portable terminal with a very thin thickness, and also easily understand that the upper limit of F# requires a sufficient amount of light in order to obtain good image quality with the small telephoto lens assembly for a portable terminal.

Specifically, as explained in the Plaintiff's Brief dated February 18, 2021 (page 26) and in this Written Submission (pages 6 to 7, Section 2. D), the configuration of "TTL≤6.5 mm" is derived from the description "TTL is smaller than the EFL" in the detailed description of the subject patent (Exhibit No. Kap-3 paragraph [0009]), and the EFL values in each of the embodiments (6.90 mm, 7 mm, 6.84 mm), and the TTL values in each of the embodiments (5.904 mm, 5.90 mm, 5.904 mm). Therefore, the claims for the corrected subject invention are limited within the scope of the detailed description of the invention, and since the corresponding configuration is described in the detailed description of the invention, the configuration is fully supported by the detailed description of the invention.

Furthermore, with respect to the numerical range of F#, "the configuration of the lens assembly having an F# smaller than 2.9" is derived from the description "the lens assembly has an F number F# < 3.2" in the means to solve the problem of the patented invention (Exhibit No. Kap-3 paragraph [0009]) and the F# values (2.80, 2.86, 2.80) in each of the Embodiments. The above configuration narrows the numerical range to sufficiently provide a large amount of light for high-definition realization within the numerical range described in the detailed description of the subject patent, and accordingly, it is also supported by the detailed description of the invention in the literal sense.

In addition, in light of the Patent Office Examination Guidelines[14], which stipulates that the matters listed as claims in the claim part are the matters that the applicant wishes to be protected by the patent right on his/her own will among the inventions disclosed in the description of the invention, or the decision[15] ruling that the applicant can freely decide which elements to describe in the claim part, the claims of the invention of the subject patent, which are selected within the numerical ranges described in the detailed description of the subject patent, are supported by the detailed description of the invention.

The Patent and Utility Model Examination Guidelines state that, when determining whether the claims are supported by the detailed description of the invention or not, this is done by mainly reviewing whether the claim is outside the scope that a person with ordinary skill in the relevant technical field can grasp from the description of the invention.

Exhibit No. Kap-35 Patent/Utility Model Examination Guidelines (Amendment December 14, 2020. Patent Office Regulation No. 117)
Whether corresponding matters are described in the description of the invention should be judged by examining whether or not an invention is being claimed in the claims beyond the scope of the invention that can be understood by those skilled in the art in consideration of the purpose of Article 42(4)1 from the description of the invention, rather than by examining the claims and the description of the invention are identical in text.

14

See lower half of page 2402 of Exhibit No. Kap-35, "2. Acknowledgement of the Invention"
Matters listed as claims in the claim part are the matters for which the applicant wishes to be protected by the patent right on his/her own will among the inventions disclosed in the description of the invention in accordance with the claim description method of Articles 42(4) and (8) of the Patent Act.

15

Patent Court Decision 2009Heo4742 on December 24, 2009
Article 42(4)(3) of the Old Patent Law, which requires that the claims of the patented invention describe only the matters essential to the constitution of the invention, should only be understood as not only forbidding to interpret, after grant, the scope with other elements that were not described at the time of grant as if such elements were originally described in the claims on the basis of the absence of the description of elements necessary for the constitution of the invention of the corresponding patent, but also confirming the fact that all the elements described in the claims should be understood as essential elements and that no element should be viewed as non-essential element due to their low importance (see Supreme Court Decision 2003Hu2072 on November 24, 2006), and it cannot be regarded as a regulation requiring that all the configurations necessary to achieve the purpose and effect of the patented invention be described in the claims, and it can be said that the applicant can freely decide which elements are described in the claims, taking into consideration whether to narrow or broaden the technical scope of the invention, and apart from the fact that one cannot obtain a patent registration for reasons such as an incomplete invention or lack of inventive step when he or she fails to describe some of the elements that are deemed necessary for achieving the purpose and effect of the patented invention in the claims, the above cannot be based to say that a patent registration cannot be obtained for violation of Article 42(4)3 of Old Patent Law.

Furthermore, the Patent Court ruled that "It is not necessary to describe all the embodiments supporting the claims in the specification of the patented invention, so even if the embodiments related to the four-way confirmation are not described, this cannot be the reason for lack of description (Patent Court Decision 2011Heo620 on August 10, 2011).

Therefore, the TTL or F# numerical range of the subject patent is fully supported by the detailed description of the invention, and the Defendant's claim to the contrary is without merit.

E. The TTL or F# numerical range of the subject patent are clearly and concisely stated in the claims.

The Defendant asserts that the TTL or F# numerical range has no lower limit, so the claims are not clearly and concisely stated (Defendant's Brief dated May 28, 2021 pages 10 - 11).

However, for the subject patent, it cannot be considered that there is reason for invalidity of lack of description because the lower limit of the numerical range is not described.

As explained above, the subject patent has technical significance at the upper limits of TTL and F#. Therefore, even if there is no description of the lower limits of TTL and F# in the subject patent, a person skilled in the art can clearly grasp the subject patent as the upper limit of TTL and F#.

Moreover, <u>the subject patent limits the upper limits of TTL and F# and rather limits the scope of the subject patent to a narrower range with respect to TTL and F#, which does not make the invent unclear compared to the conventional skills due to such a numerical range.</u>

Therefore, the defendant's claim is also without merit.

F. The invention of the subject patent has no reason for invalidation on new matter ground.

The Defendant claims that ‘TTL numerical range’ and ‘F# numerical range’ of the subject patent and ‘the configuration of combined refractive power of the second and third lens elements’ were added by amendment during the course of the application, so they correspond to the addition of new matters (Defendant's Brief dated May 28, 2021 page 11).

However, the above defendant's claim is without merit.

The TTL and F# of the subject patent are within the scope of the matters described in the priority application specification.

Specifically, on page 2, lines 11-13 of the priority application specification, ‘TTL is smaller than the EFL’ is written in parallel with ‘the TTL/EFL ratio is smaller than 0.9’ along with the conjunction ‘and’.

The effective focal length of the lens assembly is marked EFL and the total track length on an optical axis between the object-side surface of the first lens element and the electronic sensor is marked TTL. In all embodiments, TTL is smaller than the EFL and the TTL/EFL ratio is smaller than 0.9. In an embodiment, the TTL/EFL ratio

[Exhibit No. Eul-7, page 2]

Since both 'TTL<EFL' and 'TTL/EFL < 0.9’ are included in the priority application specification, the original text of the priority application explicitly discloses 'TTL/EFL < 1.0.

On the other hand, since the EFL values (6.9 mm, 7 mm, 6.84 mm),[16] TTL/EFL < 1.0 configuration is described in priority application specification, TTL ≤ 6.5 mm is also within the above numerical range.

Even when looking at the claims initially attached to the patent application, claim 10 states that “the lens assembly has an F number less than 3.2” (Exhibit No. Eul-3-1, page 22), and the detailed description also presents “F# < 3.2” and each embodiment "F# = 2.80, 2.86, 2.80” (Exhibit No. Kap-3, [0009], [0020], [0026], [0032]), so it is clear that F# < 2.9 is within the numerical range of the claims initially attached to the patent application.

16

Exhibit No. Eul-7 Pages 6, 8, 10
Embodiment **100** provides a field of view (FOV) of 44 degrees, with EFL = 6.90mm, F# = 2.80 and TTL of 5.904 mm. Thus and advantageously, the ratio TTL/EFL = 0.855. Advantageously, the Abbe number of the first, third and fifth lens element is Embodiment **200** provides a FOV of 43.48 degrees, with EFL = 7 mm, F# = 2.86 and TTL = 5.90 mm. Thus and advantageously, the ratio TTL/EFL = 0.843.
Embodiment **300** provides a FOV of 44 degrees, EFL = 6.84 mm, F# = 2.80 and TTL = 5.904 mm. Thus and advantageously, the ratio TTL/EFL = 0.863. Advantageously,

[Claim 10] The optical lens assembly of claim 1, wherein the lens assembly has an F number smaller than 3.2.

[Exhibit No. Eul-3-1 page 22]

[0009]	TTL is defined as the distance on an optical axis between the object-side surface of the first lens element and the image sensor. “EFL" has its regular meaning. In all embodiments, TTL is smaller than the EFL, i.e. the TTL/EFL ratio is smaller than 1.0. In some embodiments, the TTL/EFL ratio is smaller than 0.9. In an embodiment, the TTL/EFL ratio is about 0.85. In all embodiments, the lens assembly has an F number F# < 3.2. In an embodiment, the focal length of the first lens element fl is smaller than TTL/2,
[0020]	Embodiment 100 provides a field of view (FOV) of 44 degrees, with EFL = 6.90 mm, F# = 2.80 and TTL of 5.904 mm.
[0026]	Embodiment 200 provides a FOV of 43.48 degrees, with EFL = 7 mm, F# = 2.86 and TTL = 5.90mm. Thus and advantageously,
[0032]	Embodiment 300 provides a FOV of 44 degrees, EFL = 6.84 mm, F# = 2.80 and TTL = 5.904 mm. Thus and advantageously,

[Exhibit No. Kap-3 paragraphs [0009], [0020], [0026], [0032]]

<u>In the priority application specification {Exhibit No. Eul-7 page 2 line 13 - page 3 line 5 (original text), page 29 line 14 - page 30 line 13 (translation)}, the technical descriptions corresponding to the detailed description paragraphs [0009] - [0011] of the subject patent are described.</u> Therefore, the configuration of combined refractive power of the second and the third lens elements’ is also described in the first specification etc.

[0009]	TTL is defined as the distance on an optical axis between the object-side surface of the first lens element and the image sensor. “EFL" has its regular meaning. In all embodiments, TTL is smaller than the EFL, i.e. the TTL/EFL ratio is smaller than 1.0. In some embodiments, the TTL/EFL ratio is smaller than 0.9. In an embodiment, the TTL/EFL ratio is about 0.85. In all embodiments, the lens assembly has an F number F# < 3.2. In an embodiment, the focal length of the first lens element fl is smaller than TTL/2, the first, third and fifth lens elements have each an Abbe number ("Vd") greater than 50, the second and fourth lens elements have each an Abbe number smaller than

30, the first air gap is smaller than d2/2, the third air gap is greater than TTL/5 and the fourth air gap is smaller than 1.5ds. In some embodiments, the surfaces of the lens elements may be aspheric.
[0010] In an optical lens assembly disclosed herein, the first lens element with positive refractive power allows the TTL of the lens system to be favorably reduced. The combined design of the first, second and third lens elements plus the relatively short distances between them enable a long EFL and a short TTL. The same combination, together with the high dispersion (low Vd) for the second lens element and low dispersion (high Vd) for the first and third lens elements, also helps to reduce chromatic aberration. In particular, the ratio TTL/EFL < 1.0 and minimal chromatic aberration are obtained by fulfilling the relationship 1.2x|f3| > |f2| > 1.5xfl, where "f" indicates the effective focal length of the lens element and the numerals 1, 2, 3, 4, 5 indicate the number of the lens elements.
[0011] The relatively large distance between the third and the fourth lens elements plus the combined design of the fourth and fifth lens elements assist in bringing all fields' focal points to the image plane. Also, because the fourth and fifth lens elements have different dispersions and have respectively positive and negative power, they help in minimizing chromatic aberration.

[Exhibit No. Kap-3 paragraphs [0009]-[0011]]

The effective focal length of the lens assembly is marked "EFL" and the total track length on an optical axis between the object-side surface of the first lens element and the electronic sensor is marked "TTL". In all embodiments, TTL is smaller than the EFL, i.e. the TTL/EFL ratio is smaller than 0.9. In an embodiment, the TTL/EFL ratio is about 0.85. In all embodiments, the lens assembly has an F number F# < 3.2. In an embodiment, the focal length of the first lens element f1 is smaller than TTL/2, the first, third and fifth lens elements have each an Abbe number ("Vd") greater than 50, the second and fourth lens elements have each an Abbe number smaller than 30, the first air gap is smaller than $d_2/2$, the third air gap is greater than TTL/5 and the fourth air gap is smaller than $d_5/2$. In some embodiments, the surfaces of the lens elements may be aspheric.
In an optical lens assembly disclosed herein, the first lens element with positive refractive power allows the TTL of the lens system to be favorably reduced. The combined design of the first, second and third lens elements plus the relatively short distances between them enable a long EFL and a short TTL. The same combination, together with the high dispersion (low Abbe number) for the second lens element and low dispersion (high Vd) for the first and third lens elements, also helps to reduce chromatic aberration. In particular, the ratio TTL/EFL<1.0 and minimal chromatic aberration are obtained by fulfilling the relationship 1.2×|f3|>|f2|>1.5×f1, where "f" indicates the effective focal length of the lens element and the numerals 1, 2, 3, 4, 5 indicate the number of the lens elements.
[0011] The relatively large distance between the third and the fourth lens elements plus the combined design of the fourth and fifth lens elements assist in bringing all fields' focal points to the image plane. Also, because the fourth and fifth lens elements have different dispersions and have respectively positive and negative power, they help in minimizing chromatic aberration.

[Exhibit No. Eul-7 page 29 line 14 - page 30 line 13]

It was judged that the amendments 1 to 13 were made within the scope of the matters described in the specification or drawing of the subject patent, and this is extremely reasonable.[17]

As a result, the Defendant's allegations are without merit, so the corrected invention has no reason for invalidation on new matter ground.

G. In the corrected subject invention, the inventive step is not denied Reference 1 alone or Reference 1 combined with the known technology (or Prior Art in Exhibit No. Eul-5,6).

The Defendant stated that in the corrected subject invention, the inventive step is denied in view of Reference 1 alone or Reference 1 combined with the known technology (or Prior Art in Exhibit No. Eul-5,6)(the Defendant's Briefs dated February 8, 2021).

However, the Defendant's allegations are without merit.

(A) Reference 1 is impossible to implement and it is difficult for a person skilled in the art to grasp its technical contents, so it cannot be used as a preparation for the judgment of inventive step.

As explained on the pages 3-6, Plaintiff's Written Submission dated June 3, 2021, the second imaging optic system LN2 of the Embodiment 2 of Reference 1 is configured to have the image side surface of the fourth lens and the object side surface of the fifth lens overlap spatially, making it impossible to implement in practice. This is also acknowledged by The Defendant.

It is also difficult for a person skilled in the art to grasp the above configuration as a feasible invention.

17

Exhibit No. Kap-1, Written Judgement page 13
The amendments 1 to 13 correspond to a reduction of scope of the claims, and are made within the scope of the matters described in the specification or drawings of the subject patent, and because there is no change occurred due to above amendments 1 to 13 in terms of purpose or effect of the subject patent, it cannot be considered that the subject patent is substantially expanded or changed, and accordingly, the request for correction of the subject case is acknowledged to be the legitimate amendment that satisfies Articles 136(1), (3) and (4) of Patent Act applied by Articles 133(2)(1) and (4) of Patent Act.

Therefore, Reference 1 cannot be compared in the judgment of inventive step.

(B) Even if Reference 1 can be comparable, the inventive step is not denied by Reference 1 of the corrected subject invention.

In the corrected subject invention, 'the configuration in which the focal length of the first lens element f1 is smaller than TTL/2', 'the configuration in which the first lens element has convex object-side surface and convex image-side surface', and 'the configuration in which the F# of the lens assembly is less than 2.9' are different those of Reference 1, which is not disputed between the parties.

The Defendant stated that 'the configuration in which the focal length of the first lens element f1 is smaller than TTL/2' can be derived based on "1.0<fFw/fFm < 1.5 - conditional equation (1)" disclosed in paragraph [0019] of Reference 1, and 'the configuration in which the first lens element has convex object-side surface and convex image-side surface' has no technical meaning, and claimed that 'the configuration in which the F# of the lens assembly is less than 2.9' is a meaningless numerical limitation that has no technical substance.

However, as explained on pages 6-14, Petitioner's Written Submission dated June 3, 2021, the Defendant's allegations are unreasonable.

1) Regarding the configuration in which the focal length f1 of the first lens element is smaller than TTL/2

Paragraph [0019] of Reference 1 claimed by the Defendant has the following description.

Exhibit No. Kap-3, Written Judgement page 13
[0019] "1.0<fFw/fFm<1.5 ...(1) wherein fFw: Combined focal length of the first lens and the second lens in the first imaging optical system, fFm: Combined focal length of the first lens and the second lens in the second imaging optical system" [0024] "Exceeding the lower limit of the conditional equation 1 means that the focal length of the front group of the second imaging optical system is shorter (that is, the power is stronger) than the focal length of the front group of the first imaging optical system. That is, since the focal length of the

> entire system of the second imaging optical system is relatively long, the positive power is weakened as a whole, but on the contrary, the lower limit defines the conditions under which the power is stronger than that of the front group of the first imaging optical system having a short focal length of the entire system. By satisfying this conditional equation 1, the telephoto tendency of the second imaging optical system can be strengthened, so that the effect of reducing the overall length of the device can be obtained."

[Exhibit No. Eul-4, translation of paragraphs [0019] and [0024]]

By the way, the above conditional equation 1 relates to the combined focal length of the first lens and the second lens, not the focal length of the first lens.

For example, the specification of Reference 1 mentioned by the Defendant (Exhibit No. Eul-4 paragraphs [0019] and [0024], marking yellow) also discloses only the combined focal length of the first lens (L1) and the second lens (L2), and the focal length of the first lens (L1) is not described separately.

Also, the above paragraph of Reference 1 does not describe the configuration for making f1 smaller than TTL/2. Rather, all of the embodiments disclosed in Reference 1 have f1 greater than TTL/2 (See, Exhibit No. Eul-4 paragraph [0076], marking yellow[18]).

Exhibit No. Eul-4 [0076] Table 1

		Embodiment 1		Embodiment 2	
		LN1	LN2	LN1	LN2
Focal length of the entire system [mm]	fw or fm	2.73	4.32	3.70	5.51
Fno	FNOw or FNOm	4.00	4.00	3.00	4.00
Lens overall length (infinity) [mm]	TLw or TLm	3.04	3.65	4.45	4.91
Maximum image height [mm]	2Y'	5.12	5.12	5.80	5.80
Full angle of view [deg]	2ωw or 2ωm	86.329	61.28	76.18	55.52
L1 Focal length [mm]	f1w or f1m	2.60	2.10	2.47	2.54

[18] According to Exhibit No. Eul-4 paragraph [0076] Table 1, in Embodiment 1, f1 is 2.1, which is higher than TTL/2, 1.825(=3.65/2), and in Embodiment 2, f1 is 2.54, which is higher than TTL/2, 2.455(=4.91/2).

2) Regarding to 'the configuration in which the first lens element has convex object-side surface and convex image-side surface’

The Defendant stated that whether the image-side surface of the first lens element is concave or convex has no technical meaning in relation to the corrected subject invention, so that the above configuration can be easily derived by a person skilled in the art by any selection.

However, it is obvious to those skilled in the art of lens systems that components such as the focal length of the lens are different depending on the shape of the lens, and thus the effect of the lens system is different. Therefore, it is obvious that the shape of the lens has technical significance in the design of the lens system.

All of the telephoto optical systems of Reference 1 adopt a characteristic configuration in which the image-side surface of the first lens element is concave, and on the contrary, there is no motivation for changing the image-side surface of the first lens element into a convex shape.

3) Regarding to 'the configuration in which the F# of the lens assembly is less than 2.9’

The Defendant stated that ‘the configuration having F# less than 2.9’ is a meaningless numerical limitation that has no technical substance.

However, as mentioned above, the configuration that limits the minimum amount of light in the requirements of F# is a configuration that is adopted considering that a sufficiently large amount of light is required for high-definition implementation, which is a characteristic configuration of the corrected subject invention regarding 'small telephoto lens assembly’. It is different from the conventional wide-angle optical system having a short focal length.

In Reference 1, F# is described as characteristic element in claim 7[19].

19

Exhibit No. Eul-4 page 30
[7] The imaging device of any one of claims 1 to 6, characterized by satisfying the following conditional equation 5. 0.6<FNOw/FNOm< 1.3 … (5) wherein FNOw: F number of the first imaging optic system, FNOm: F number of the second imaging optic system.

Therefore, the Defendant's allegations are without merit.

On the other hand, in Reference 1, it is described that it is more advantageous to achieve downsizing of the whole to make the second imaging optical system darker than the first imaging optical system (Exhibit No. Eul-4 paragraph [0038]), The specific values of F# of the first imaging optical system (wide angle) and the second imaging optical system (telephoto) in each embodiment are described (Exhibit No. Eul-4 paragraph [0076]).

Exhibit No. Eul-4 paragraphs [0037] and [0038]

【0037】

It is preferable to satisfy the following conditional equation 5.

0.6<FNOw/FNOm< 1.3 ... (5)

wherein

FNOw: F number of the first imaging optic system.

FNOm: F number of the second imaging optic system.

【0038】

If the F-number is significantly different at the time of switching, the impression of blurring will change significantly, which will be unnatural for the user, so F number is preferable to be close to the first, second imaging optic systems in order to satisfy conditional equation 5. It is advantageous to make the second imaging optical system darker than the first imaging optical system in order to achieve overall miniaturization.

Exhibit No. Eul-4 paragraph [0076]

		Embodiment 1		Embodiment 2	
		LN1	LN2	LN1	LN2
Focal length of the entire system [mm]	fw or fm	2.73	4.32	3.70	5.51
Fno	FNOw or FNOm	4.00	4.00	3.00	4.00
Lens overall length (infinity) [mm]	TLw or TLm	3.04	3.65	4.45	4.91
Maximum image height [mm]	2Y'	5.12	5.12	5.80	5.80

Full angle of view [deg]	2ωw or 2ωm	86.32	61.28	76.18	55.52

"0.6<FNOw/FNOm<1.3 ... (5)" described in paragraph [0037] of Reference 1 relates to the F# ratio between the wide-angle optical system and the telephoto optical system, and is directed to keep the F# of the two optical systems within a certain range so as to prevent the image from being unnatural because the impression of blurring change greatly during transition.

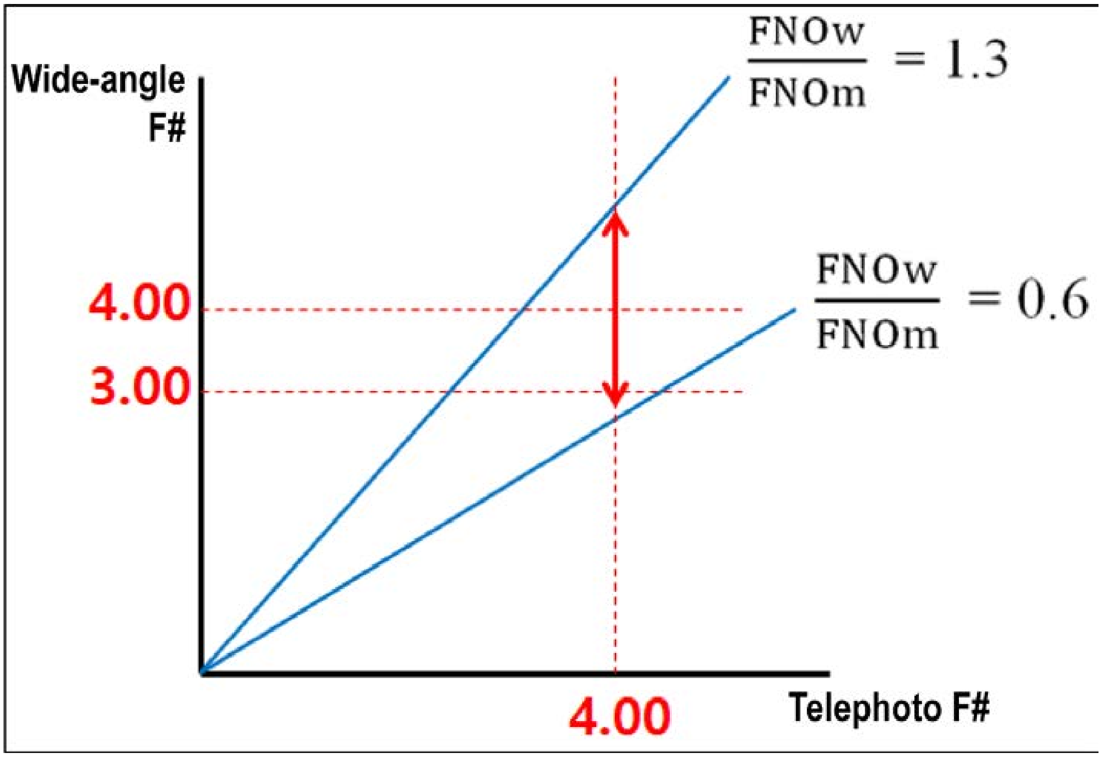
Here, in two embodiments presented by Reference 1, F# of the wide-angle optical system LN1 has different values of 3.00 or 4.00, whereas the F# of the telephoto optical system LN2 is the same value of 4.00. That is, Reference 1 has a motivation to change the F# of the wide-angle optical system in the F# ratio between the two optical systems, but does not suggest a motivation to change the F# of the telephoto optical system (e.g., smaller than 4.00).

Reference 1, rather than trying to change the F# of the telephoto optical system, designed the telephoto optical system's F# to 4.00, and in view of the impression of blurring, just set the wide-angle optical system's F# to 3.00 or 4.00 (see Exhibit No. Eul-4 paragraph [0038]).

> If the F number is significantly different at the time of switching, the impression of blurring will change significantly, which will be unnatural for the user, so F number is preferable to be close in the first, second imaging optical systems in order to satisfy the conditional equation (5). The first imaging optical system

[Exhibit No. Eul-4 paragraph [0038]]

As such, Reference 1 does not provide a motivation to lower the F# of the telephoto optical system, but is for adjusting the F# of the wide-angle optical system based on the F# of the telephoto optical system, 4.00, so that the ratio between the wide-angle optical system and the telephoto optical system is in the range of 0.6 to 1.3.



On the other hand, the effect obtained by setting F# to less than 2.9 in the invention of the subject patent corresponds to a heterogeneous effect that is difficult to predict in Reference 1. In Reference 1, it is difficult to find a motivation to change the F# of the telephoto optical system in order to obtain this effect.

As a result, a person skilled in the art cannot derive 'the configuration in which the F# of the lens assembly is less than 2.9' from Reference 1.

(C) In the corrected subject invention, the inventive step is not denied by the combination of Reference 1 and Prior Art in Exhibit No. Eul-5,6.

In pages 3-18 of the Defendant's Written Submission dated February 8, 2021, after disassembling the components corresponding to the differences 1 to 3 above, the Defendant claims that the disassembled individual components were disclosed in Prior Art of Exhibit No. Eul-5,6, or that such individual components are a commonly used technique.

However, as explained in pages 14-32 of the Petitioner's Written Submission dated June 3, 2021, the Defendant's allegations does not take into account the organic relationship between the components described in the corrected subject invention, and unlike the Defendant's allegations, the lens system for a general camera cannot be combined with the compact telephoto lens system for a portable terminal because the lens systems themselves are different, and the configuration claimed by the Defendant is not a commonly used technique.

	Defendant's allegations			Unjustness of Defendant's claims
	f1<TTL/2	Both-side surface convexity of the first lens element	F#<2.9	
Reference 1	X	X	X	Does not disclose the components
Exhibit No. Eul-5-2	o	o	-	F# significantly exceeds 2.9 Normal large camera telephoto lens other than TTL ≤ 6.5 mm cannot be combined with the subject patent
Exhibit No. Eul-5-3	o	o	-	F# significantly exceeds 2.9 Normal large camera telephoto lens other than TTL ≤ 6.5 mm cannot be combined with the subject patent
Exhibit No. Eul-5-4	o	o	-	F# significantly exceeds 2.9 Normal large camera telephoto lens other than TTL ≤ 6.5 mm cannot be combined with the subject patent
Exhibit No. Eul-6-1	-	-	o	Wide-angle lens other than TTL/EFL < 1 cannot be combined with the subject patent

Exhibit No. Eul-6-2	-	-	o	Not f1<TTL/2 Normal large camera telephoto lens cannot be combined with the subject patent
Exhibit No. Eul-6-3	-	-	o	Not f1<TTL/2 Normal large camera telephoto lens cannot be combined with the subject patent
Exhibit No. Eul-6-4	-	-	o	Wide-angle lens other than TTL/EFL < 1 cannot be combined with the subject patent
Exhibit No. Eul-6-5	-	-	o	Wide-angle lens other than TTL/EFL < 1 cannot be combined with the subject patent

First, the Defendant's allegations, after disassembling the plurality of components described in the claims, only examined whether the disassembled individual components are known, so the Defendant's allegations are in direct opposition to the Supreme Court Reporter regarding the judgment of inventive step.[20]

20

Supreme Court Decision 2006Hu2097 on November 29, 2007
When a claim described in claims of a patented invention consists of a plurality of components, the technical idea as a whole in which each component is organically combined is the subject of the judgment of inventive step, but each component is not independently judged of the inventive step, therefore, in judging the inventive step of the patented invention, after disassembling a plurality of components described in the claims, it should not be examined only whether the disassembled individual components are known, but the difficulty of the composition as an organically combined whole should be examined based on the unique problem-solving principle, wherein the unique effect of the invention as a whole combined composition should also be considered (see Supreme Court Decision 2005Hu3277 on September 6, 2007).

In addition, Exhibit No. Eul-6-1 which was submitted by the Defendant states that the design of the lens system for a general large camera is clearly different from the design of a small lens assembly for a portable terminal,[21] and the lens shape of a general camera is not suitable for that of a portable terminal, so the lens assembly for a portable terminal cannot be based on the lens system for a general camera, but must be redesigned.

Furthermore, it cannot be recognized as a commonly used technique just because it has been disclosed in several prior documents, and it cannot be regarded as a commonly used technique by extracting only some components from the entire lens assembly organically combined.[22]

In the end, the Defendant's allegations are without merit, and the inventive step of the corrected subject invention cannot be denied by Reference 1 alone or by the combination of Reference 1 and the known technology (Exhibit No. Eul-5,6).

H. The filing date of the corrected subject invention is retroactive to the priority date, so Reference 2 cannot be a prior invention of the expanded earlier application.

On pages 19-22 of the Defendant's Written Submission dated February 8, 2021, the Defendant states that the technical description of the specification of the corrected subject invention are not the same as the that of the priority application, so that the filing date cannot be retroactive to the priority date.

However, those of ordinary skill in the art can understand that, in view of the technical common sense at the time of filing, TTL and F# numerical ranges of the invention of the subject patent, and the configuration of “a pair of second and third lens elements having a negative optical power together” are all described in the specification of the priority application, etc.

In the end, since the filing date of the corrected subject invention is retroactive to the priority date, July 4. 2013, Reference 2 with the priority date of October 31, 2013 cannot be a prior invention of the expanded earlier application.

[21] See pages 17-22, Plantiff's Written Submission dated June 3, 2021

[22] See pages 23-33, Plantiff's Written Submission dated June 3, 2021

4. Conclusion

As described above, the Defendant's allegations are without merit, and the corrected subject invention has no reason for invalidation. Therefore, please cancel the trial decision in this case.

References

1. Reference 1 Science Encyclopedia, search result screen for “response function”

1. Reference 2 Specifications for OPPO X907

1. Reference 3 Specifications for Fujitsu Arrows ES IS12F

1. Reference 4 Specifications for Huawei Ascend Pls

1. Reference 5 Specifications for Apple iPhone 5

1. Reference 6 Manual for Samsung Galaxy S4

1. Reference 7 Specifications for SONY Xperia Z Ultra

1. Reference 8 Samsung Homepage Folded Lens Screen

Attached documents

1. 1 copy of each of the above reference materials

August 2, 2021

Paintiff's attorney

YULCHON Attorneys at Law

Attorney Choi Jeong-yeol

Attorney Jeong Sang-tae

Attorney Lee Han-Gyeol

Attorney Kim Ha-young

C&S PATENT AND LAW OFFICE

Patent Attorney Son Won

Patent Attorney Hwang Woo-Taek

Patent Attorney Lee Eui-Hoon

Patent Attorney Yoon Byung-Hoon

Patent Attorney Ahn Seong-su

Patent Attorney Kwak In-Young

(To) Patent Court 3rd Div.

brief that "it is clearly recognized that the telephoto lens assembly mounted on a mobile phone was researched and developed at least before 2005." Attachment at 2.

Second, the brief shows that Corephotonics' statement about "one precedent document" in its brief was based on an incompletely developed factual record. LG cites four new prior art references that purportedly show telephoto lens assemblies in a mobile phone. Attachment at 2–5. As Corephotonics will explain in its brief next week, this makes for a total of ten unrelated patents or applications cited by Apple or its supplier in proceedings against Corephotonics purportedly showing telephoto lens assemblies in mobile phones prior to the '408 patent priority date.

Third, the brief illustrates a difference in substantive law between Korea and the U.S. which underlies the Corephotonics statements Apple points to. Although LG's counsel is aware of the U.S. IPR proceedings, *e.g.* Attachment at 17, neither they nor Corephotonics mentioned in the Korean case the other mobile phone telephoto lens art Apple has cited in its IPRs. *See* Ex. 2015 at 112:7–114:18. That is because those other references were unpublished patent applications as of Corephotonics' priority date. While unpublished applications are considered to be known to the POSITA for purposes of obviousness in the United States, they are not considered within the prior art for the purposes of "inventive step" in Korea. *KIPO Patent Examination Guidelines*, January 2021 at 303–04, 341–43 (https://www.kipo.go.kr/upload/en/download/Patent_Examination_Guidelines_2021.pdf).

No cause exists for the extraordinary step of allowing new evidence, in support of new factual positions and new legal theories, all after the FWD. First, the statements Apple cites addressed claims amended to require TTL < 6.5 mm (Paper 33, Att. at 1–3), and the brief is clear that "portable terminals" are mobile phones requiring a TTL < 6.5 mm (*id.* at 4–6). Scaling Kawamura by a factor of 14.5 to work with a 1/3-inch sensor like Golan yields a TTL of 13.49 mm. (Ex. 1013, ¶ 48, Appx. B.) Even assuming that ***no*** telephoto lenses for "portable terminals" requiring TTL < 6.5 mm had existed in 2013, that would not contradict anything said by Corephotonics or relied on by the Board in the FWD concerning the availability of telephoto lens designs that could have been used instead of a scaled Kawamura lens.

Second, the quoted statements were expressly made as statements about the (not fully developed) record in the Korean case. (Paper 33, Att. at 2 n.1.) Not only was that record addressing different patent claims, but it also reflected a substantive law of "inventive step" that is different from that in the U.S. (*See* Paper 34 at 2, citing *KIPO Patent Examination Guidelines*, January 2021 at 303–04, 341–43.)

Finally, Apple's new factual position resting on the Korean brief—that there were "hardly any" or "only one" "telephoto lens assemblies applied to portable terminals" in 2013 (Paper 33 at 2)—is directly opposite to one Apple has repeatedly taken to this Board. In *six* different IPR petitions, where Apple has prevailed in the FWD or that are still pending, Apple has asserted that "lens assemblies for

[mobile/cell] phones were well known, including telephoto [lenses/lens assemblies]" (IPR2018-01140, Pet. at 5; IPR2019-00030, Pet. at 7; IPR2020-00896, Pet. at 4; IPR2020-00878, Pet. at 4; IPR2020-00897, Pet. at 4), or "mobile devices with an integrated camera having Telephoto and Wide lenses were well known" (IPR2020-00877, Pet. at 4). Across these six petitions, Apple has cited at least five unrelated references—Ogino, Chen, Iwasaki, Hsieh, and Parulski—that predate the '408 patent and that Apple alleges show telephoto lenses in mobile phones or mobile devices. Since Apple contends that Golan describes a telephoto lens, that makes a sixth.

As explained in Paper 34, Apple's lens supplier has cited a total of five examples of a "telephoto lens assembly mounted on a mobile phone" that predate the '408 patent: Konno (a.k.a. Reference 1, Paper 33, Att. at 1; also cited in IPR2020-01146), Kubota, Labaziewicz, Hideo, and Yasauki (Paper 34, Att. at 2). Labaziewicz has a disclosure that overlaps with Parulski, so only ***ten*** of the examples of telephoto lens assemblies in mobile phones or mobile devices by Apple and its supplier are unique.

After losing in the FWD is too late for Apple to change its consistently held factual position, particularly when Apple and its supplier have produced so much evidence showing the new position to be false. Because the statements in the Korean brief reflect different claims, a different record, and different substantive law, and further they do not contradict the Board's findings in the FWD, no cause exists to admit the Korean brief in the service of Apple's belated change in position.

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

APPLE INC.
Petitioner,

v.

COREPHOTONICS, LTD.,
Patent Owner.

IPR2020-00489
U.S. Patent No. 10,015,408 B2

PETITIONER APPLE INC.'S NOTICE OF APPEAL

via E2E
Patent Trial and Appeal Board

via Hand Delivery
Director of the United States Patent and Trademark Office
c/o Office of the General Counsel, 10B20
Madison Building East
600 Dulany Street
Alexandria, VA 22314

via CM/ECF
United States Court of Appeals for the Federal Circuit

Pursuant to 28 U.S.C. § 1295(a)(4)(A), 35 U.S.C. §§ 141(c), 142, and 319, and 37 C.F.R. §§ 90.2(a), 90.3, 28 U.S.C. § 1651, 5 U.S.C. §§ 701-706, and Federal Circuit Rule 15(a)(1), Petitioner Apple Inc. ("Petitioner") provides notice that it appeals to the United States Court of Appeals for the Federal Circuit from the Final Written Decision of the Patent Trial and Appeal Board ("Board") entered July 26, 2021 (Paper 32), from the Decision Denying Petitioner's Request on Rehearing entered July 27, 2022 (Paper 41), and from all underlying and related orders, decisions, rulings, and opinions regarding U.S. Patent No. 10,015,408 B2 ("the '408 patent") in *Inter Partes* Review IPR2020-00489.

In accordance with 37 C.F.R. § 90.2(a)(3)(ii), the expected issues on appeal include, but are not limited to: the Board's error(s) in determining that challenged claims 5 and 6 of the '408 patent are not unpatentable, the Board's denial of Petitioner's request to admit and consider a pertinent U.S. provisional patent application as well as a brief prepared and submitted by the patent owner in connection with a proceeding before the Patent Court of Korea, the Board's failure to provide a ruling (at the time this Notice is being filed) regarding Petitioner's unopposed request to include as exhibits in the agency record the parties' requests regarding additional evidence (conducted via e-mail pursuant to Board procedures), and all other issues decided adversely to Petitioner in any orders, decisions, rulings, or opinions.

Pursuant to 35 U.S.C. § 142 and 37 C.F.R. § 90.2(a), a copy of this Notice is being filed with the Director of the United States Patent and Trademark Office and with the Patent Trial and Appeal Board. In addition, a copy of this Notice and the required docketing fees are being filed with the Clerk's Office for the United States Court of Appeals for the Federal Circuit via CM/ECF.

Respectfully submitted,

Dated: September 26, 2022

/David W. O'Brien/
David W. O'Brien
Reg. No. 40,107

HAYNES AND BOONE, LLP
600 Congress Avenue
Suite 1300
Austin, TX 78701
Telephone: (512) 867-8457
Facsimile: (512) 867-8644
david.obrien.ipr@haynesboone.com

CERTIFICATE OF FILING

The undersigned hereby certifies that, in addition to being electronically filed through PTAB E2E, a true and correct copy of the above-captioned PETITIONER APPLE INC.'S NOTICE OF APPEAL is being filed by hand with the Director on September 26, 2022, at the following address:

Director of the United States Patent and Trademark Office
c/o Office of the General Counsel, 10B20
Madison Building East
600 Dulany Street
Alexandria, VA 22314

The undersigned also hereby certifies that a true and correct copy of the above-captioned PETITIONER APPLE INC.'S NOTICE OF APPEAL and the filing fee is being filed via CM/ECF with the Clerk's Office of the United States Court of Appeals for the Federal Circuit on September 26, 2022.

Respectfully submitted,

Dated: September 26, 2022

/David W. O'Brien/
David W. O'Brien
Reg. No. 40,107
Attorney for Petitioner Apple Inc.

CERTIFICATE OF SERVICE

Pursuant to 37 C.F.R. § 42.6, this is to certify that a true and correct copy of the foregoing "Petitioner Apple Inc.'s Notice of Appeal" was served on the Patent Owner Corephotonics, Ltd. as detailed below:

Date of service	September 26, 2022
Manner of service	Electronic Service by E-mail: − nrubin@raklaw.com − jchung@raklaw.com − mfenster@raklaw.com − jtsuei@raklaw.com
Documents served	**Petitioner Apple Inc.'s Notice of Appeal**
Persons served	Neil A. Rubin (nrubin@raklaw.com) C. Jay Chung (jchung@raklaw.com) Marc A. Fenster (mfenster@raklaw.com) James S. Tsuei (jtsuei@raklaw.com) Russ August & Kabat 12424 Wilshire Blvd., 12th Floor Los Angeles, CA 90025

Respectfully submitted,

/David W. O'Brien/
David W. O'Brien
Reg. No. 40,107
Attorney for Petitioner Apple Inc.

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

APPLE INC.,
Petitioner

v.

COREPHOTONICS LTD.,
Patent Owner

U.S. Patent No. 10,015,408

DECLARATION OF JOSÉ SASIÁN, PH.D. UNDER 37 C.F.R. § 1.68 IN SUPPORT OF PETITION FOR INTER PARTES REVIEW

TABLE OF CONTENTS

I. INTRODUCTION

1. I, José Sasián, have been retained by counsel for Apple Inc. ("Apple" or "Petitioner") as a technical expert in connection with the proceeding identified above. I submit this declaration in support of Apple's Petition for *Inter Partes* Review of U.S. Patent No. 10,015,408 ("the '408 Patent").

2. Compensation for my work in this matter is based on an hourly rate. In addition, reasonable and customary expenses associated with my work and testimony in this matter are reimbursed. This compensation is not contingent on the outcome of this matter, nor is it contingent on the specifics of my testimony. I have no personal or financial stake, nor any interest in the outcome of the present proceeding.

3. In the preparation of this declaration, I have studied:

(1) The '408 Patent, APPL-1001;

(2) The prosecution file history of the '408 Patent ('853 App), APPL-1002;

(3) U.S. Patent Application Publication No. 2012/0026366 to Golan, et al. ("Golan"), APPL-1005;

(4) Warren J. Smith, MODERN LENS DESIGN (1992) ("Smith"), APPL-1006;

(5) JP Patent Application Publication No. S58-62609 to Kawamura ("Kawamura"), Certified English translation and Original, APPL-1007;

(6) U.S. Patent No. 7,777,972 to Chen et al. ("Chen"), APPL-1008;

(7) ZEMAX Development Corporation, ZEMAX Optical Design Program User's Manual, February 14, 2011 ("ZEMAX User's Manual"), APPL-1009;

(8) U.S. Patent No. 7,990,422 to Ahiska et al. ("Ahiska"), APPL-1010;

(9) U.S. Patent App. Pub. No. US20120314296 to Shabtay et al. ("Shabtay 296"), APPL-1011;

(10) U.S. Patent No. 8,553,106 to Scarff ("Scarff"), APPL-1012;

(11) Japanese Patent Pub. No. JP2013106289 to Konno et al. ("Konno Japanese"), APPL-1014;

(12) Japanese Patent Pub. No. JP2013106289 to Konno et al., Certified English translation ("Konno"), APPL-1015;

(13) Jacobson et al., The Manual of Photography – Photographic and Digital Imaging, 2000 ("Jacobson"), APPL-1016.

4. In forming the opinions expressed below, I have considered:

(1) The documents listed above;

(2) References on the face of the '408 Patent, including:

a. U.S. Patent Application Pub. No. 2017/0276911 to Huang;

b. U.S. Patent Application Pub. No. 2009/0002839 to Sato;

c. U.S. Patent Application Pub. No. 2013/0335833 to Liao.

(3) Any additional documents discussed below; and

(4) My own knowledge and experience based upon my work in the fields of imaging systems as described below.

II. QUALIFICATIONS

5. My qualifications and professional experience are described in my *Curriculum Vitae*, a copy of which can be found in exhibit APPL-1004. The following is a brief summary of my relevant qualifications and professional experience.

6. I have substantial academic and industry experience with imaging systems, including the design and integration of optics, sensors, and digital processing in imaging systems. My research interests have included most aspects of image generation and creation, and the major themes of my research has been directed to optical sciences and optical engineering, including optical instrumentation, optical design, and optical fabrication and testing.

7. I am currently a full-time, tenured Professor of Optical Sciences at the College of Optical Sciences at the University of Arizona in Tucson, Arizona, a position I have held since 2002. As a professor, I teach and perform research in the field of imaging systems. For example, I teach my students how to design lenses

and mirrors and how to think about light so that they can design sharp imaging systems.

8. As part of my academic and research responsibilities I am frequently involved with the design, fabrication, and testing of optical devices. Prior to receiving tenure, I was an Associate Professor of Optical Sciences at the University of Arizona from 1995 to 2001. Prior to joining the University of Arizona faculty, I was a member of the technical staff of AT&T Bell Laboratories from 1990 to 1995. From 1984 to 1987, I was a Research Assistant, and from 1988 to 1990, I was a Research Associate, in the Optical Sciences Center at the University of Arizona. From 1976 to 1984, I was an optician at the Institute of Astronomy at the University of Mexico.

9. I received a Bachelor of Science degree in Physics from the University of Mexico in 1982, a Master of Science degree in Optical Sciences from the University of Arizona in 1987, and a Ph.D. degree in Optical Sciences from the University of Arizona in 1988. My research areas include optical design, fabrication, and testing of optical instruments, astronomical optics, diffractive optics, opto-mechanical design, light in gemstones, lithography optics, and light propagation.

10. At the University of Arizona, I have taught the courses Lens Design OPTI 517 (1997-present), Introduction to Aberrations OPTI 518 (2005-present),

Advanced Lens Design OPTI 696A (2008, 2012, 2017), Illumination Optics Seminar (1997-2000), Introduction to Opto-mechanics OPTI 690 (1998, 2001, 2003, 2004, 2005) and Optical Shop Practices OPTI 597A (1996-present). I teach students how to design lens systems, how to grind, polish, and test aspheric surfaces, how to mount lenses properly so that their physical integrity is preserved, and how to align lens systems.

11. I have directed several student reports, theses, and dissertations in the areas of optical imaging. I have lectured regarding my work, and have published, along with students and colleagues, over one hundred scientific papers in the area of optics. These include technical papers, student reports and theses done under my direction, related to miniature lenses. For example:

- Yufeng Yan, Jose Sasian, "Miniature camera lens design with a freeform surface," Proc. SPIE 10590, International Optical Design Conference 2017, 1059012 (27 November 2017); doi: 10.1117/12.2292653
- Dmitry Reshidko, Jose Sasian, "Optical analysis of miniature lenses with curved imaging surfaces," Appl. Opt. Oct. 54(28):E216-23, 2015.
- Sukmock Lee, Byongoh Kim, Jiyeon Lee, and Jose Sasian, "Accurate determination of distortion for smart phone cameras," Applied Optics, Vol. 53, Issue 29, pp. H1-H6 (2014).

- Ying Ting Liu, "Review and Design of a Mobile Phone Camera Lens for 21.4 Mega-Pixels Image Sensor," M. Sc. Report, University of Arizona, 2017.
- Luxin Nie, "Patent Review of Miniature Camera Lenses," M. Sc. Report, University of Arizona, 2017.
- Cheng Kuei-Yeh, "Cell phone zoom lens design and patent research," M. Sc. Report, University of Arizona, 2010.
- Rob Bates, "Design for Fabrication: Miniature Camera Lens Case Study," M. Sc. Report, University of Arizona, 2008.

12. Since 1995, I have been a consultant and have provided to industry solutions to a variety of projects that include lenses for cell-phones, lenses for microscopes, and lenses for fast speed photography. I also have consulted in the area of plastic optics. I hold patents and patent applications related to lens systems.

13. I have been a topical editor and reviewer for the peer-reviewed journals Applied Optics and Optical Engineering. I am a fellow of the International Society for Optics and Photonics (SPIE), a fellow of the Optical Society of America (OSA), and a lifetime member of the Optical Society of India.

14. I have served as a co-chair for the conferences "Novel Optical Systems: Design and Optimization" (1997-2006), "Optical systems alignment, tolerancing, and verification" (2007-2019), and "International Optical Design

Conference," (2002). I have taught in Japan (2014, 2016, and 2017) the course: Advanced Lens Design: Art and Science.

15. I have been a co-editor of approximately 24 published conference proceedings from SPIE. I am the author of the book, "Introduction to Aberrations in Optical Imaging Systems," by Cambridge University Press, 2013, and of the book, "Introduction to Lens Design," by Cambridge University press 2019. I am named as an inventor on approximately 13 U.S. patents.

16. A list of my publications is contained in my CV at exhibit APPL-1004.

III. LEVEL OF ORDINARY SKILL IN THE ART

17. I understand that the level of ordinary skill may be reflected by the prior art of record, and that a Person of Ordinary Skill in The Art ("POSITA") to which the claimed subject matter pertains would have the capability of understanding the scientific and engineering principles applicable to the pertinent art. I understand that a POSITA has ordinary creativity, and is not an automaton.

18. I understand that there are multiple factors relevant to determining the level of ordinary skill in the pertinent art, including (1) the levels of education and experience of persons working in the field at the time of the invention; (2) the sophistication of the technology; (3) the types of problems encountered in the field; and (4) the prior art solutions to those problems.

19. I am familiar with the imaging system art pertinent to the '408 Patent. I am also aware of the state of the art at the time the application resulting in the '408 Patent was filed. I have been informed by counsel to Apple that the earliest claimed priority date for the '408 Patent is June 13, 2013, although any given claim of the '408 Patent may or may not be entitled to the earliest claimed date.

20. Based on the technologies disclosed in the '408 Patent and the claims discussed below, I believe that a POSITA would include someone who had, as of the claimed priority date of the '408 patent, a bachelor's degree or the equivalent degree in electrical and/or computer engineering, physics, optical sciences or a related field and 2-3 years of experience in imaging systems including optics and image processing. Such a person would have had experience in analyzing, tolerancing, adjusting, and optimizing multilens systems with lens design software, would have been familiar with the specifications of lens systems, and would be familiar with image sensors and image processing. In addition, I recognize that someone with less formal education but more experience, or more formal education but less experience could have also met the relevant standard for a POSITA. I believe that I am at least a POSITA and, furthermore, I have supervised students and engineers who were also POSITAs. Accordingly, I believe that I am qualified to opine from the perspective of a POSITA regarding the '408 Patent and the claims discussed below.

21. For purposes of this Declaration, unless otherwise noted, my opinions and statements, such as those regarding the understanding of a POSITA (and specifically related to the references I listed above), reflect the knowledge that existed in the art before the earliest claimed priority date of the ’408 Patent.

IV. RELEVANT LEGAL STANDARDS

22. I have been asked to provide my opinions regarding whether claims 5-6 (the “Challenged Claims”) of the ’408 Patent would have been obvious to a POSITA at the time of the alleged invention in light of the prior art.

23. I am not an attorney. In preparing and expressing my opinions and considering the subject matter of the ’408 Patent, I am relying on certain legal principles explained to me by counsel to Apple.

24. I understand that a claim is unpatentable if it is anticipated under 35 U.S.C. § 102 or obvious under 35 U.S.C. § 103.

A. Anticipation

25. I have been informed by counsel that a patent claim is unpatentable as anticipated if each element of that claim is present either explicitly or inherently in a single prior art reference. I have also been informed that, to be an inherent disclosure, the prior art reference must necessarily disclose the limitation.

B. Obviousness

26. I have been informed and I understand that a claimed invention is

unpatentable under 35 U.S.C. § 103(a) if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious to a POSITA at the time the invention was made. I understand that the appropriate analysis for determining obviousness of a claimed invention takes into account factual inquiries, including the level of ordinary skill in the art, the scope and content of the prior art, and the differences between the prior art and the claimed subject matter as a whole.

27. I have been informed and I understand that the United States Supreme Court has recognized several rationales for combining references or modifying a reference to show obviousness of claimed subject matter. Some of these rationales include the following: (a) combining prior art elements according to known methods to yield predictable results; (b) simple substitution of one known element for another to obtain predictable results; (c) use of a known technique to improve a similar device (method, or product) in the same way; (d) applying a known technique to a known device (method, or product) ready for improvement to yield predictable results; (e) choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success; and (f) some teaching, suggestion, or motivation in the prior art that would have led a POSITA to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention. I have also been informed and I understand that a

demonstration of obviousness does not require a physical combination or bodily incorporation, but rather may be found based on consideration of what the combined teachings would have suggested to a POSITA at the time of the alleged invention.

V. THE ’408 PATENT

A. Summary of the ’408 Patent

28. The ’408 Patent is titled “Dual Aperture Zoom Digital Camera” and was issued on July 3, 2018. (APPL-1001), ’408 Patent, Title. The ’408 Patent is directed to a “dual-aperture zoom digital camera operable in both still and video modes.” (APPL-1001), ’408 Patent, Abstract. In its background, the ’408 Patent acknowledges that using digital zooming is an “alternative approach [to optical zooming] for approximating the zoom effect,” and use of “**multi-aperture** imaging systems to approximate the effect of a zoom lens **are known**.” (APPL-1001), ’408 Patent, 1:46-51, 1:55-56. For example, the ’408 Patent acknowledges that US Patent Application Publication No. 2008/0030592 to Border et al. (“Border”) describe a digital camera including “two lenses having different focal lengths,” but alleges that Border “requires, in video mode, very large processing resources in addition to high frame rate requirements and high power consumption (since both cameras are fully operational).” (APPL-1001), ’408 Patent, 2:7-34. For further example, the ’408 Patent acknowledges that US Patent Application Publication No.

2010/0277619 to Scarff ("Scarff") describes a camera with two lens/sensor combinations to provide a zoomed image based on a zoom amount requested by a user, but alleges that Scarff "leads to parallax artifacts when moving to the Tele camera in video mode." (APPL-1001), '408 Patent, 2:35-51.

29. "[T]o address and correct many of the problems and disadvantages of known dual-aperture optical zoom digital cameras," the '408 Patent alleges that it provides "an overall zoom solution that refers to all aspects: optics, algorithmic processing and system hardware (HW). The proposed solution distinguishes between video and still mode in the processing flow and specifies the optical requirements and HW requirements. In addition, it provides an innovative optical design that enables a low TTL/EFL ratio using a specific lens curvature order." (APPL-1001), '408 patent, 4:3-12.

30. Specifically, the '408 Patent describes that "optical design considerations were taken into account to enable reaching optical zoom resolution using small total track length (TTL)," which "refer to the Tele lens." (APPL-1001), '408 patent, 12:38-41.

31. The '408 Patent provides two embodiments of the Tele lens illustrated in FIGS. 8 and 9 respectively, which are reproduced below. The embodiment of FIG. 8 includes "a fourth lens 808 with positive power," while claim 5 requires a fourth lens element with negative power. (APPL-1001), '408 patent, 12:48.

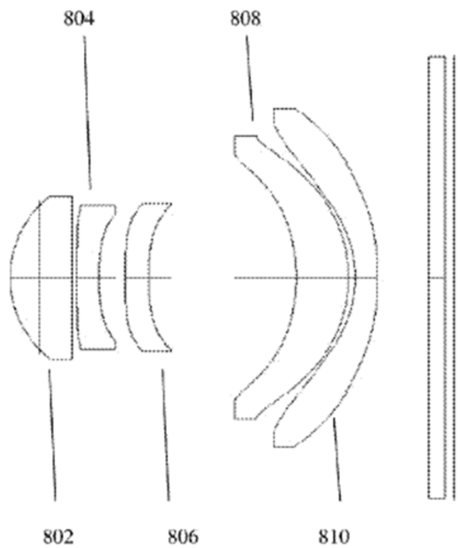


FIG. 8

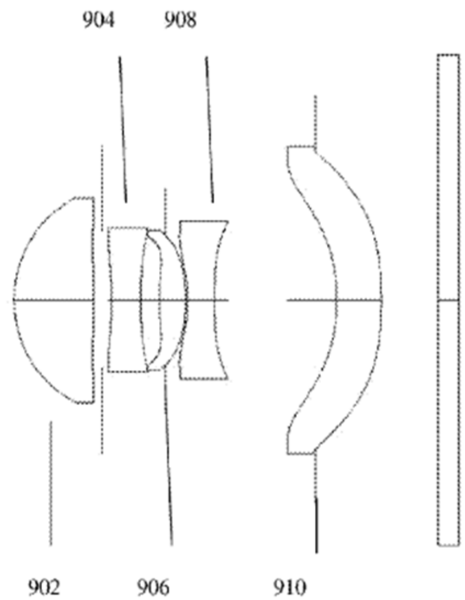


FIG. 9

(APPL-1001), ’408 Patent, FIGS. 8 and 9

32. Regarding the embodiment of FIG. 9, the ’408 Patent describes that “the camera has a lens block that includes (along an optical axis starting from an object) a first lens element 902 with positive power a second lens element 904 with negative power, a third lens element with positive power 906 and a fourth lens element with negative power 908, and a fifth lens element 910 with positive or negative power. In this embodiment, f=7.14, F#=3.5, TTL=5.8 mm and FOV=22.70°.” (APPL-1001), ’408 Patent, 12:54-62. It is noted that the ’408 Patent does not provide a lens prescription table (including e.g., axial distances, radii of curvature, Abbe numbers, etc.).

33. Representative independent claim 5 of the ’408 Patent is reproduced below:

> 5. A zoom digital camera comprising:
> a) a first imaging section that includes a fixed focal length first lens with a first field of view (FOV1) and a first image sensor; and
> b) a second imaging section that includes a fixed focal length second lens with a second FOV (FOV2) that is narrower than FOV, and a second image sensor,
> wherein the second lens includes five lens elements along an optical axis starting from an object starting with a first lens element with positive power,
> wherein the five lens elements further include a second lens element with negative power, a fourth lens element with negative power and a fifth lens element,
> wherein a largest distance between consecutive lens elements along the optical axis is a distance between the fourth lens element and the fifth lens element, and
> wherein a ratio of a total track length (TTL) to effective focal length (EFL) of the second lens is smaller than 1.

(APPL-1001), '408 Patent, 13:1-18.

34. As I discuss below in more detail, the system and method presented in the '408 Patent, namely, a zoom digital camera using 1) first and second imaging sections with respective first and second lenses and image sensors, and 2) the second lens including five lens elements with specific power, distance, and TTL/EFL ratio configurations were well known to persons of ordinary skill in the art before the earliest priority date of the '408 Patent.

B. Prosecution History of the '408 Patent

35. As my opinions are focused on claims 5-6 (the "Challenged Claims") of the '408 Patent, the summary of prosecution history below is focused on claims 8, 9, and 11 in the prosecution history. Specifically, in notice of allowance,

Examiner's amendment canceled claim 8, amended claim 9, and added claim 11. (APPL-1002), '853 App, 164-167. Claims 9 and 11 issued as claims 5 and 6 respectively.

36. On February 5th, 2017, the Applicant filed U.S. Patent Application No. 15/424853 ("the '853 App") including claims 1-9, which ultimately issued as the '408 Patent. (APPL-1002), '853 App, 1-39.

37. In the Office Action mailed April 7, 2017, the Examiner rejected claims 8-9 as unpatentable over U.S. Patent App. Pub. No. 2008/0030592 to Border et al. ("Border") in view of U.S. Patent App. Pub. No. 2012/0314296 to Shabtay et al. ("Shabtay '296"). (APPL-1002), '853 App, 74-75.

38. In the response filed July 17, 2017, the Applicant did not amend claims 8-9, but argued that Shabtay '296 does not teach, and in fact, teaches away from the required TTL to EFL ratio as claimed. (APPL-1002), '853 App, 96.

39. In the Office Action of October 12, 2017, the Examiner indicated that claims 8-9 are allowed. '853 App, 115. In the response filed October 19, 2017, the Applicant amended claim 9 to change "a fifth lens element with positive or negative power" to "a fifth lens element with positive power." (APPL-1002), '853 App, 134.

40. On January 5, 2018, an examiner interview was conducted to discuss amendments for claims 8-9 to distinguish prior art JP2013/106289 and US Patent

No. 9,405,099 to Jo and add new claim 11. (APPL-1002), '853 App, 170.

41. On February 9, 2018, a notice of allowance issued, including an examiner's amendment to cancel claim 8, amend claim 9, and add a new claim 11. (APPL-1002), '853 App, 159-169.

42. The '408 Patent issued on June 13, 2018. The allowed claim subset including claims 9 and 11 were issued as claims 5 and 6 of the '408 Patent, respectively.

VI. CLAIM CONSTRUCTION

43. It is my understanding that in order to properly evaluate the '408 Patent, the terms of the claims must first be interpreted. It is my understanding that for the purposes of this *inter partes* review, the claim terms are given their ordinary and accustomed meaning as would be understood by one of ordinary skill in the art, unless the inventor has set forth a special meaning for a term. In order to construe the following claim terms, I have reviewed the entirety of the '408 Patent, as well as its prosecution history.

A. "s*mooth transition*" (claim 6)

44. It is my opinion that, in the context of the '408 Patent, a POSITA would have understood "*smooth transition*" to mean "transition with a reduced discontinuous image change," for example, a transition with a continuous image change.

45. The specification of the '408 Patent supports the proposed construction. Regarding the term "smooth transition" under "Video Mode Operation/Function," the '408 Patent provides,

> Smooth Transition
>
> **When a dual-aperture camera switches the camera output between sub-cameras or points of view, a user will normally see a "jump" (discontinuous) image change.** However, a change in the zoom factor for the same camera and POV is viewed as a **continuous change**. **A "smooth transition" is a transition between cameras or POVs that minimizes the jump effect.**

(APPL-1001), '408 Patent, 10:35-43. As such, the '408 Patent defines the term "jump" to mean "discontinuous" image change, and defines a "smooth transition" to be a transition that minimizes the "discontinuous" image change. Furthermore, the '408 Patent provides that "smooth transition" includes at least a transition with "a continuous change."

46. The '408 Patent provides examples of techniques that may be used to achieve smooth transition:

> This **<u>may</u>** include matching the position, scale, brightness and color of the output image before and after the transition. However, an entire image position matching between the sub-camera outputs is **<u>in many cases</u>** impossible, because parallax causes the position shift to be dependent on the object distance. Therefore, in **<u>a smooth transition</u>** as disclosed herein, the position matching is achieved only in the ROI region while scale brightness and color are matched for the entire output image area.

(APPL-1001), '408 Patent, 10:43-51. A POSITA would have understood that these descriptions are merely examples for achieving smooth transition, and therefore are

not definitions for smooth transition.

47. It is therefore my opinion that a POSITA would have understood "*smooth transition*" to mean "transition with a reduced discontinuous image change," for example, a transition with a continuous image change.

VII. GROUNDS

A. Ground 1: Claims 5-6 are unpatentable under 35 U.S.C. § 103 over Golan and Kawamura

48. In my opinion, Golan in view of Kawamura renders claims 5 and 6 obvious.

1. Summary of Golan

49. U.S. Patent Application Publication No. 2012/0026366 to Golan et al. ("Golan") was published on February 2, 2012. Golan is titled "Continuous Electronic Zoom for an Imaging System with Multiple Imaging Devices Having Different Fixed FOV," and discloses providing a video output with "a continuous electronic zoom for an image acquisition system, the system including multiple imaging devices having different fixed FOV." (APPL-1005), Golan, FIG. 1, Title, [0002].

50. Golan teaches use of wide and tele lenses and employs wide and tele images during digital zooming, which "facilitates a light weight electronic zoom with a large lossless zooming range." (APPL-1005), Golan, [0009]. Specifically, as illustrated in FIG. 1 below, Golan discloses zoom control sub-system 100 for an image acquisition system including "multiple image sensors, each with a fixed and

preferably different FOV." (APPL-1005), Golan, [0036]. Golan's zoom control subsystem 100 includes a tele image sensor 110 coupled with a narrow lens 120 having a tele FOV 140, a wide image sensor 112 coupled with a wide lens 122 having a wide FOV 142, a zoom control module 130 and an image sensor selector 150. (APPL-1005), Golan, FIG. 1, [0037].

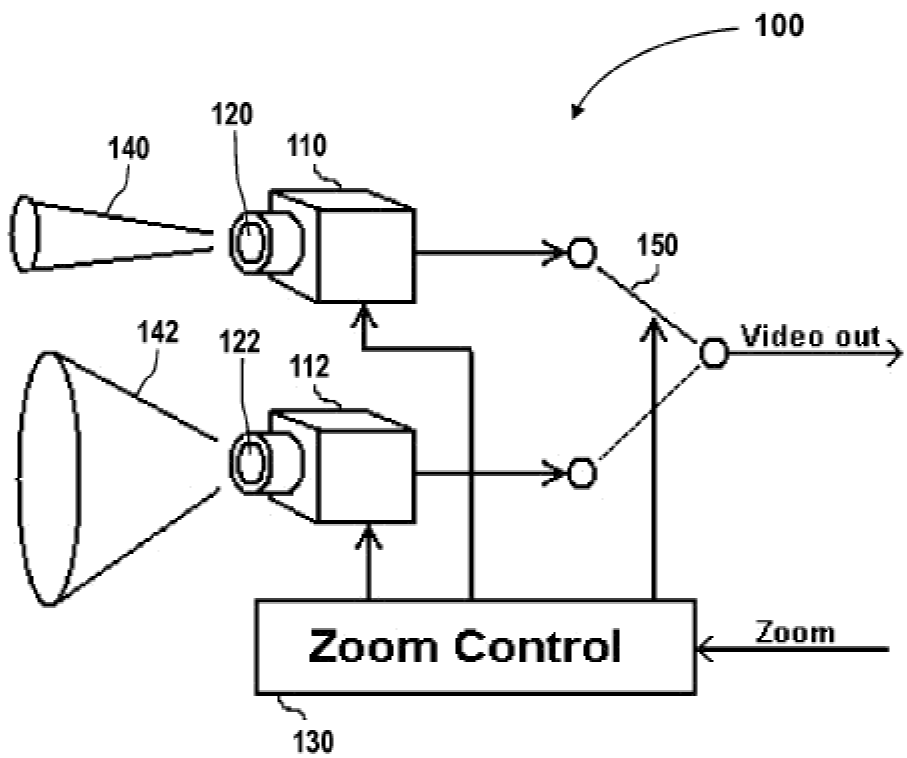


Fig 1

(APPL-1005), Golan, FIG. 1

51. Golan teaches that, in embodiments of FIGS. 1 and 2, each image frame of video output is generated based on an acquired image frame from "the relevant

image sensor" of an image acquisition device selected based on the user input zoom factor. (APPL-1005), Golan, FIGS. 1-2, [0039]. Specifically, Golan teaches that a zoom control circuit 130 that receives a required zoom from an operator of the image acquisition system and selects the relevant image sensor (110 or 112) by activating image sensor selector 150 position. (APPL-1005), Golan, [0039].

52. Golan teaches that "alignment between the wide image sensor array and the tele image sensor array is computed, to facilitate **continuous electronic zoom with uninterrupted imaging, when switching back and forth between the wide image sensor array and the tele image sensor array**." (APPL-1005), Golan, Abstract. Specifically, Golan describes that "an electronic[] calibrati[on] is performed to determine the alignment offsets between wide image sensor array 110 and tele image sensor array 112," (APPL-1005), Golan, [0038], and that the "calibration of the alignment, between the first image sensor array and the second image sensor array, **facilitates continuous electronic zoom with uninterrupted imaging**, when **switching** back and forth between the first image sensor array and the second image sensor array." (APPL-1005), Golan, [0015]. The electronic calibration is performed preferably with sub-pixel accuracy. *Id.*

2. Summary of Kawamura

53. Kawamura is titled "Telephoto Lens," and describes a "telephoto lens of a four-group, five-lens configuration." (APPL-1007), Kawamura, Title, Scope of

Patent Claim.

54. Specifically, Kawamura's telephoto lens system is designed to "provide a lens that keeps a compactness of an overall length to a conventional level of a telephoto ratio of about 0.96 to 0.88," "has an excellent image-formation performance due to favorably correcting spherical aberration of both a reference wavelength and color," and also with "decreasing chromatic aberration in magnification." (APPL-1007), Kawamura, 1.

55. Kawamura offers a number of examples (examples 1-4) that each include five lens elements. (APPL-1007), Kawamura, 1, FIGS. 1, 3, 6, 8. In each embodiment, the telephoto lens system includes a four-group, five-lens configuration including:

> in order from an object side, a first lens, which is a positive meniscus lens that is convex toward the object side; a second lens and a third lens, which are a laminated positive meniscus lens of a negative meniscus lens and positive meniscus lens having a lamination surface that is convex toward the object side; a fourth lens, which is a negative lens having a rear surface with a large curvature that is concave toward an image-surface side; and a fifth lens, which is a positive lens.

(APPL-1007), Kawamura, 1.

56. To achieve the object of keeping a compactness while having an excellent image-formation performance, Kawamura teaches that each embodiment satisfies following conditions (1) to (8):

(1) $0.3F < F_{1 \cdot 2 \cdot 3} < 0.5F$

(2) $1.0F < F_{1 \cdot 2 \cdot 3 \cdot 4} < 2.5F$

(3) $0.1F < d_1 + d_2 + d_3 + d_4 + d_5 + d_6 < 0.2F$

(4) $0.1F < d_7 < 0.3F$

(5) $30 < \nu_4 < 50$

(6) $0.1F < r_4 < 0.25F$

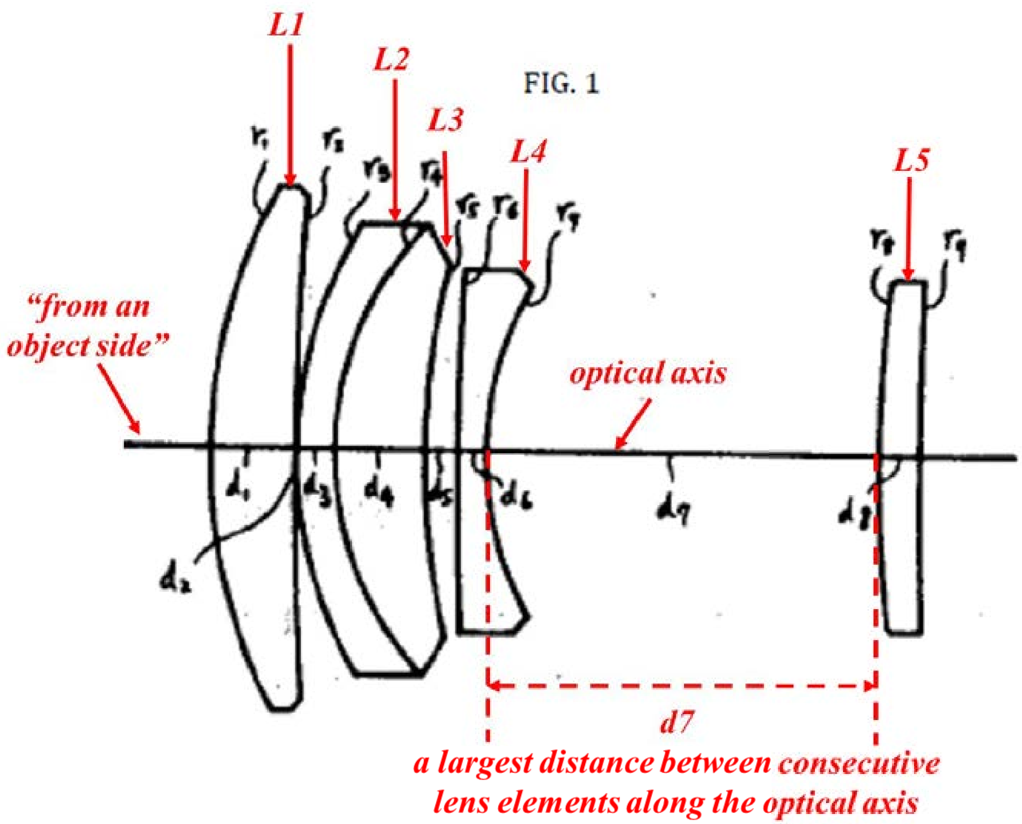
(7) $0.05 < n_2 - n_3 < 0.3$

(8) $5 < \nu_3 - \nu_2 < 50$

(APPL-1007), Kawamura, 1.

57. Kawamura describes each of the eight conditions in detail. (APPL-1007), Kawamura, 2-3. For example, Kawamura explains, "[c]ondition (1) is a condition that, in connection with conditions (2) and (3), indicates an allocation of a focal length necessary to set a telephoto ratio to about 0.96 to 0.88 and form a framework of the telephoto lens that favorably corrects aberration." (APPL-1007), Kawamura, 2. Kawamura further explains that condition (4) relating to d7 (a distance between lens elements 4 and 5) "is a condition relating to a position of the fifth lens. If d7 is greater than the upper limit, a diameter of the fifth lens is too large to maintain an appropriate peripheral light amount, which is not preferable in terms of frame configuration. Moreover, if d7 is smaller than the lower limit, coma aberration arises, which is not preferable due to correction thereof being difficult." (APPL-1007), Kawamura, 2.

58. For each of the examples 1-4, Kawamura provides figures and a prescription table including numerical values for the design. As an example, FIG. 1 and corresponding table of example 1 are reproduced below:



(APPL-1007), Kawamura, FIG. 1, annotated

Example 1

1 : 4.1   F = 200.079 ω = 12.3°

NO.	r	d	N	ν
1	57.091	9.00	1.60311	60.7
2	330.000	0.20		
3	45.039	4.00	1.67270	32.1
4	33.450	9.60	1.48749	70.1
5	81.000	3.50		
6	387.380	3.00	1.57501	41.5
7	34.361	41.80		
8	146.228	4.34	1.74950	35.3
9	552.040			

d7
a largest distance between consecutive lens elements along the optical axis

$F_{1\cdot 2\cdot 3}$ = 74.912

$F_{1\cdot 2\cdot 3\cdot 4}$ = 356.466

$d_1 + d_2 + d_3 + d_4 + d_5 + d_6$ = 29.3

(APPL-1007), Kawamura, 2, Table for Example 1, annotated

59. As shown in the annotated FIG. 1 and table of example 1 of Kawamura above, the telephoto lens configuration of Kawamura includes five lens elements annotated as L1 through L5, and a largest distance between consecutive lens elements along the optical axis is a distance d7 between the fourth lens element and the fifth lens element.

3. Reasons to Combine Golan and Kawamura

60. A POSITA would have been motivated to apply Kawamura's

teachings of a telephoto lens including five lens elements in the digital camera of Golan to produce the obvious, beneficial, and predictable results of a digital camera including a tele lens with a compactness of an overall length while having an excellent image-formation performance as taught by Kawamura. Because Golan does not provide specific lens prescriptions, a POSITA would have had the need of using a tele lens. Furthermore, a POSITA would have been motivated to apply Kawamura's teachings of tele lens because of the imaging benefits and compactness of an overall length with excellent image-formation performance as taught by Kawamura.

61. **First**, the references are analogous prior art and are in the same field of endeavor pertaining to imaging systems including a telephoto lens. Golan discloses providing video output images using a computerized image acquisition system "having a wide image acquisition device and **a tele image acquisition device having a tele image sensor array coupled with a tele lens** having a narrow FOV, and a tele electronic zoom." (APPL-1005), Golan, Abstract. Similarly, Kawamura is titled "Telephoto Lens" and discusses a "**telephoto lens**" with "a compactness of an overall length" and "excellent image-formation performance." (APPL-1007), Kawamura, 1. Accordingly, both Golan and Kawamura disclose imaging systems including a telephoto lens.

62. **Second**, a POSITA would have been motivated to incorporate the

teachings of Golan and Kawamura because they share a need to provide a compact and light weight imaging system while providing excellent image quantity. Golan recognizes that a typical camera with a large dynamic zoom range "requires heavy and expensive lenses, as well as complex design," and has a goal to provide an imaging device with "light weight" electronic zoom. (APPL-1005), Golan, [0007]-[0008]. As such, Golan provides an explicit motivation to use a compact lens design, including a compact telephoto lens design. Furthermore, Golan recognizes the need to provide excellent image quality by providing "lossless electronic zoom" for maintaining the desired resolution and by providing "continuous electronic zoom with uninterrupted imaging." (APPL-1005), Golan, Abstract, [0004]. Similar to Golan, an objective of Kawamura is to provide a telephoto lens that "keeps a **compactness of an overall length** to a conventional level of a telephoto ratio of about 0.96 to 0.88 but has **an excellent image-formation performance**." (APPL-1007), Kawamura, 1. Furthermore, a POSITA would have recognized that Kawamura's telephoto lens provides additional benefits, including for example, a relatively large field of view and little vignetting. Here, providing a compact and light weight imaging system with excellent image performance is a need or a goal shared by Golan and Kawamura, and provides at least one reason to combine the respective teachings.

63. **Third**, combining the teachings of Kawamura with the system of

Golan would have produced operable results that are predictable. Specifically, combining Kawamura's teachings of telephoto lens design in the digital camera of Golan would have been no more than the combination of known elements according to known methods (such as modifying the tele lens 120 in zoom control subsystem of Golan according to Kawamura's teachings), and would have been obvious to a POSITA at the time of the '408 Patent to achieve the benefits of a compact imaging system with excellent image performance described by Kawamura. Petitioner's combination of Kawamura's teaching with the digital camera of Golan does not require physical incorporation of Kawamura's telephoto lens into the digital camera of Golan.

64. To the extent that modifications would have been needed in order to accommodate the teachings of Kawamura in the system of Golan, such modifications would have been within the level of ordinary skill in the art. For example, while Kawamura describes that its invention "relates to a medium telephoto lens of a brightness of about 1:4 and is applied as, for example, a lens of a focal length of about 200 mm for a screen size of 6×7 or a focal length of about 150 mm for a screen size of 4.5×6," modifications or adjustments would have been within the level of ordinary skill in the art. For example, lens scaling was a well-known practice in lens design, and a POSITA would have scaled the Kawamura lens prescriptions to fit into a digital camera of Golan while maintaining the

compactness and an excellent image-formation performance. *See, e.g.*, (APPL-1006), Smith, 57 ("A lens prescription can be scaled to any desired focal length simply by multiplying all of its dimensions by the same constants. All of the linear aberration measures will then be scaled by the same factor."); (APPL-1009), ZEMAX User's Manual, 254-355 (describing performing scaling using ZEMAX). Furthermore, it would have been within the level of ordinary skill in the art to modify Kawamura and/or Golan to use Kawamura's Tele lens in the combined digital camera of Golan and Kawamura.

4. Claim 5

[5.0] ***A zoom digital camera comprising:***

65. To the extent that this preamble is deemed limiting, Golan teaches a zoom digital camera.

66. Specifically, Golan is titled "**Continuous Electronic Zoom for an Imaging System with Multiple Imaging Devices** Having Different Fixed FOV," and teaches a zoom digital imaging system with multiple imaging devices each defining an aperture for capturing a digital image. (APPL-1005), Golan, Title. Golan explains that "**digital zoom** is a method of narrowing the apparent angle of view of **a digital still or video image**," and that "[u]sing two (or more) image sensors, having different fixed FOV, facilitates **a light weight electronic zoom with a large lossless zooming range**." (APPL-1005), Golan, [0003], [0009].

67. As shown in Fig. 1 of Golan below, Golan's image acquisition system includes a zoom control sub-system 100, which includes "a tele image sensor 110 coupled with a narrow lens 120 having a predesigned FOV 140, a wide image sensor 112 coupled with a wide lens 122 having a predesigned FOV 142, **a zoom control module 130** and an image sensor selector 150." (APPL-1005), Golan, [0037]. Golan's zoom control circuit 130 "receives a required zoom from an operator of the image acquisition system and selects the relevant image sensor (110 and 112) by activating image sensor selector 150 position. The relevant camera zoom factor is calculated by zoom control unit 130." (APPL-1005), Golan, [0039].

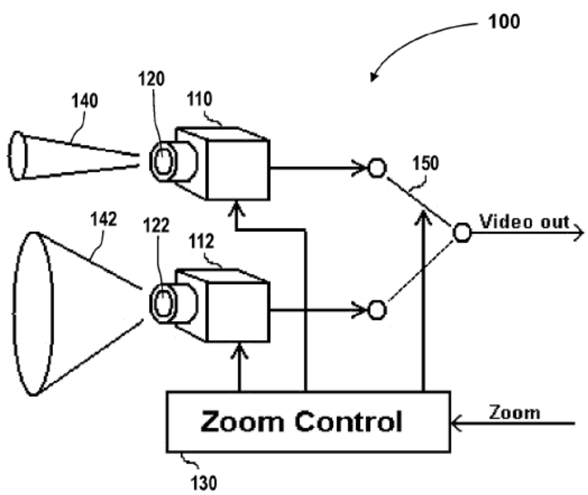


Fig 1

(APPL-1005), Golan, FIG. 1

68. In Golan's zoom control sub-system 100, each of the Wide imaging device (including wide image sensor 112 and wide lens 122) and the Tele imaging

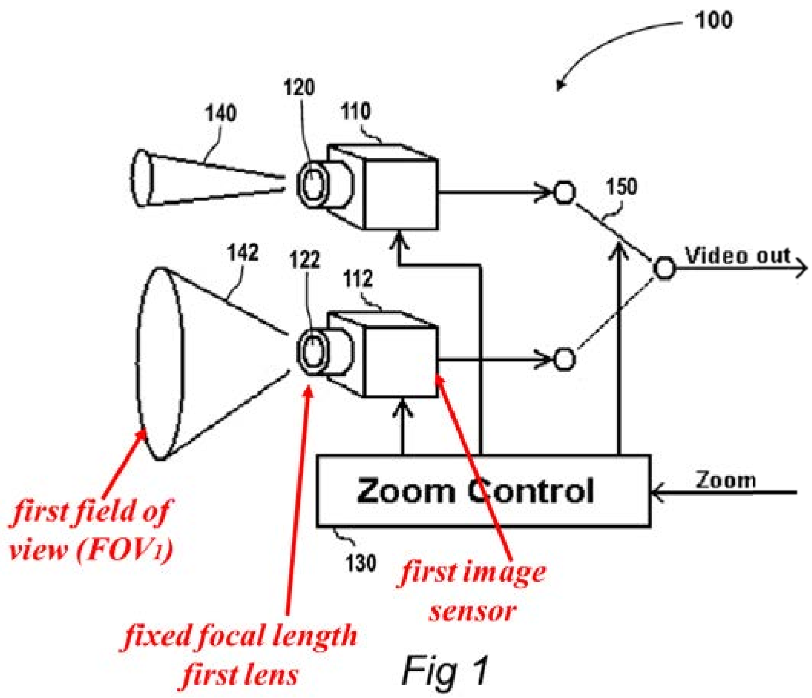
device (including tele image sensor 110 and narrow lens 120) defines an aperture for generating a corresponding digital image. As such, Golan's image acquisition system including a zoom control sub-system 100 is a digital camera providing digital zoom, therefore, teaches a zoom digital camera.

69. Therefore, Golan's image acquisition system including zoom control sub-system 100 teaches "*[a] zoom digital camera*," as recited in the claim.

[5.1] ***a) a first imaging section that includes a fixed focal length first lens with a first field of view (FOV_1) and a first image sensor; and***

70. Golan teaches a first imaging section that includes a fixed focal length first lens with a first field of view (FOV_1) and a first image sensor.

71. **First**, as shown in annotated Fig. 1 of Golan below, Golan's zoom control sub-system 100 includes a first imaging section that includes a wide lens 122 (first lens) with a FOV 142 (a first field of view (FOV_1)) and a wide image sensor 112 (first image sensor). (APPL-1005), Golan, Fig. 1, [0036]-[0037].



(APPL-1005), Golan, FIG. 1, annotated

72. **Second**, because Golan's wide lens 122 has "a **predesigned** FOV 142," it teaches a fixed focal length first lens. (APPL-1005), Golan, [0037]; *see also* (APPL-1005), Golan, [0009] ("[u]sing two (or more) image sensors, having different **fixed FOV**, facilitates a light weight electronic zoom with a large lossless zooming range"), [0036] ("Zoom control sub-system 100 includes multiple image sensors, each with a **fixed** and preferably different **FOV**, configured to provide continuous electronic zoom capabilities with uninterrupted, when switching back and forth between the image sensors."); [0043] ("Both image acquisition devices (110 and 112) include an image sensor array coupled with a lens (120 and 122, respectively), providing a **fixed FOV (tele FOV 140 and wide FOV 142,**

respectively).").

73. A POSITA would have understood that because wide lens 122 has a FOV 142 that is fixed and has a predesigned value, the wide lens 122 has a fixed focal length.

74. In a digital camera, the focal length of a lens determines the angle of FOV relative to a given sensor format, and as such, an FOV angle may be computed based on the focal length f of the lens and the diagonal (K) of the sensor. (APPL-1016), Jacobson, 48. For example, as shown in the imaging system of Figure 4.13 of Jacobson, the angle of FOV is the angle subtended at the lens by the diagonal (K) of the sensor when the lens is focused on infinity. (APPL-1016), Jacobson, 48. For a given sensor diagonal size K, a lens having a fixed FOV has a fixed focal length.

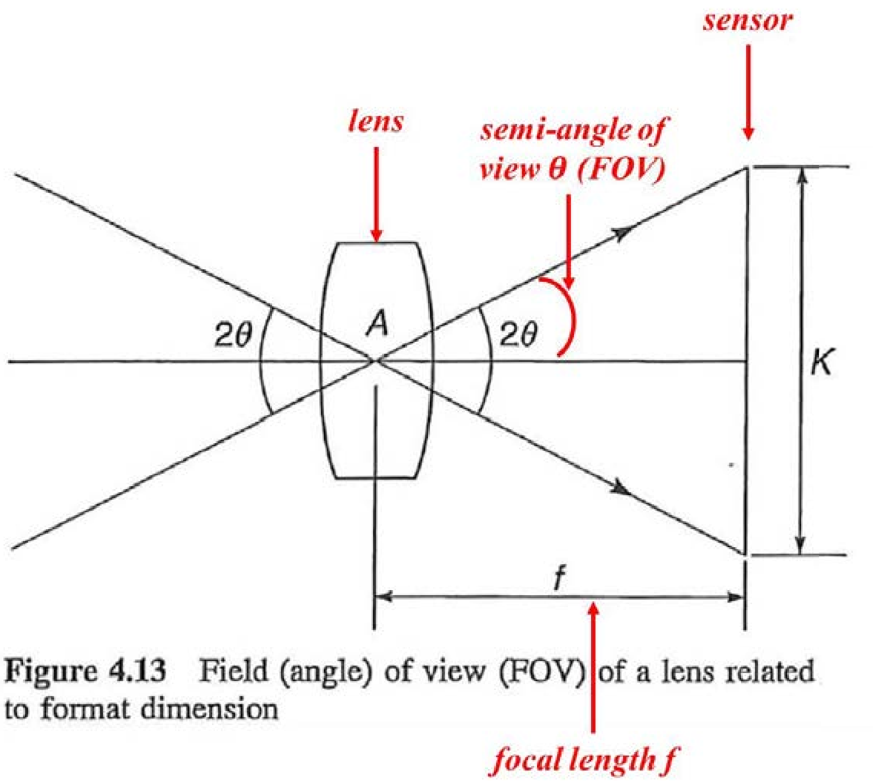


Figure 4.13 Field (angle) of view (FOV) of a lens related to format dimension

(APPL-1016), Jacobson, FIG. 4.13, annotated

75. A POSITA would have understood that normally an angle of FOV is defined as "the angle subtended at the lens by the diagonal (K) of the sensor when the lens is focused on infinity." (APPL-1016), Jacobson, 48. For example, as shown in the imaging system of FIG. 4.13 of Jacobson, the FOV angle A is twice the semi-angle of view θ, and the focal length f of a lens determines the FOV angle A relative to a given sensor format as follows:

$$A = 2\theta = 2\tan^{-1}\left(\frac{K}{2f}\right), \qquad (1)$$

(APPL-1016), Jacobson, 48.

76. The FOV in the '408 Patent is defined as "measured from the center axis

to the corner of the sensor (i.e. half the angle of the normal definition)." (APPL-1001), '408 Patent, 7:7-9. As such, a POSITA would have understood that the FOV in the '408 Patent corresponds to the semi-angle of view θ of Fig. 4.13 of Jacobson calculated as:

$$\text{FOV (as defined in }'408\text{ Patent)} = \theta = \tan^{-1}\left(\frac{K}{2f}\right). \tag{2}$$

While the analysis below is based on FOV as defined in the '408 Patent (half the angle of the normal definition), the analysis is the same for using FOV as defined in Jacobson.

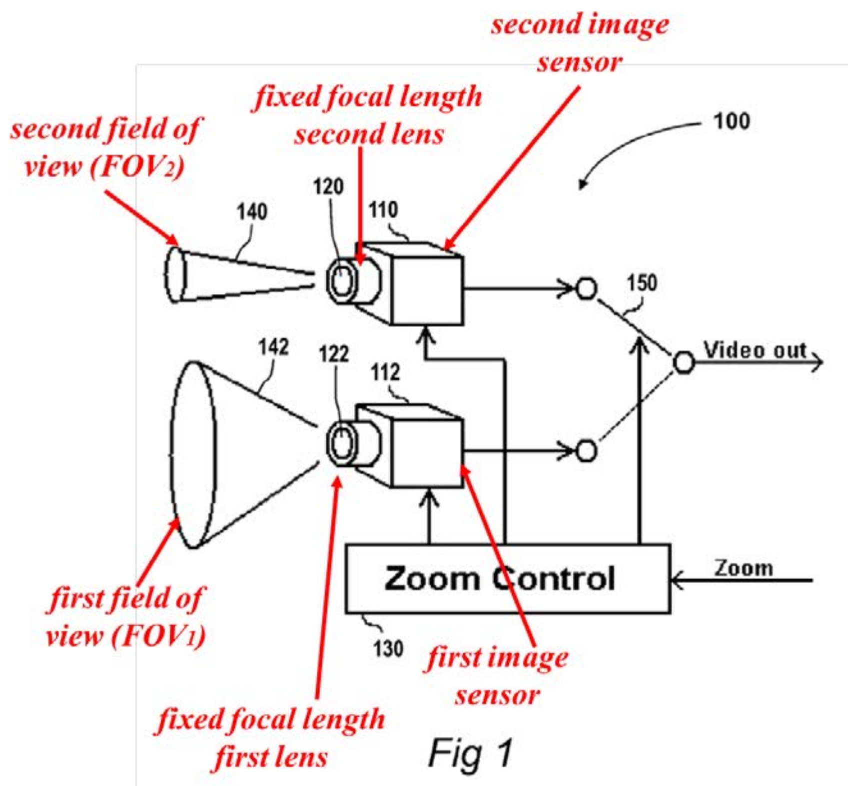
77. Because Golan's wide lens 122 of the first imaging section has a fixed FOV 142, it has a fixed focal length. Thus, Golan teaches a first imaging section with a fixed focal length first lens.

78. Therefore, Golan's zoom control sub-system 100 includes a first imaging section that includes a fixed focal length wide lens 122 with a fixed FOV 142 and a wide image sensor 112, which teaches "*a first imaging section that includes a fixed focal length first lens with a first field of view (FOV_1) and a first image sensor*" as recited in the claim.

[5.2] ***b) a second imaging section that includes a fixed focal length second lens with a second FOV (FOV_2) that is narrower than $FOV_{[1]}$, and a second image sensor,***

79. **First**, as shown in annotated Fig. 1 of Golan below, Golan's zoom

control sub-system 100 includes a second imaging section that includes a tele image sensor 110 (second sensor) coupled with a narrow lens 120 (a fixed focal length second lens) having a predesigned FOV 140 (second FOV (FOV_2)). (APPL-1005), Golan, Fig. 1, [0036]-[0037]; *see also* (APPL-1005), Golan, Abstract ("a computerized image acquisition system [] having … a tele image acquisition device having a tele image sensor array coupled with a tele lens having a narrow FOV.").



(APPL-1005), Golan, FIG. 1, annotated

80. **Second**, for the same reason discussed in [1.1], because Golan's tele lens 120 has "a **predesigned** FOV 140," it teaches a fixed focal length second lens.

(APPL-1005), Golan, [0037]; *see also* (APPL-1005), Golan, [0009], [0036], [0043]. As such, Golan teaches a second imaging section including a fixed focal length second lens.

81. **Third**, Golan teaches a FOV 140 (FOV_2) of the narrow lens 120 that is narrower than FOV 142 (FOV_1) of the wide lens 122. Specifically, Golan provides that "[p]referably, wide FOV 142 is **substantially wider than** narrow FOV 140." (APPL-1005), Golan, [0043]. In other words, Golan teaches that narrow FOV 140 (FOV_2) is narrower than wide FOV 142 (FOV_1). *See also* (APPL-1005), Golan, Fig. 1, [0009], [0037] (providing that "[i]n the optimal configuration, the FOV of wide image sensor 112 can be calculated by multiplying the FOV of tele image sensor 110 by the optimal zoom of image sensors 110 and 112," where the optimal zoom is greater than one).

82. Therefore, Golan's zoom control sub-system 100 includes a second imaging section that includes a tele image sensor 110 and a fixed focal tele lens 120 with fixed tele FOV 140 narrower than fixed wide FOV 142, which teaches "*a second imaging section that includes a fixed focal length second lens with a second FOV (FOV_2) that is narrower than $FOV_{[1]}$, and a second image sensor*" as recited in the claim.

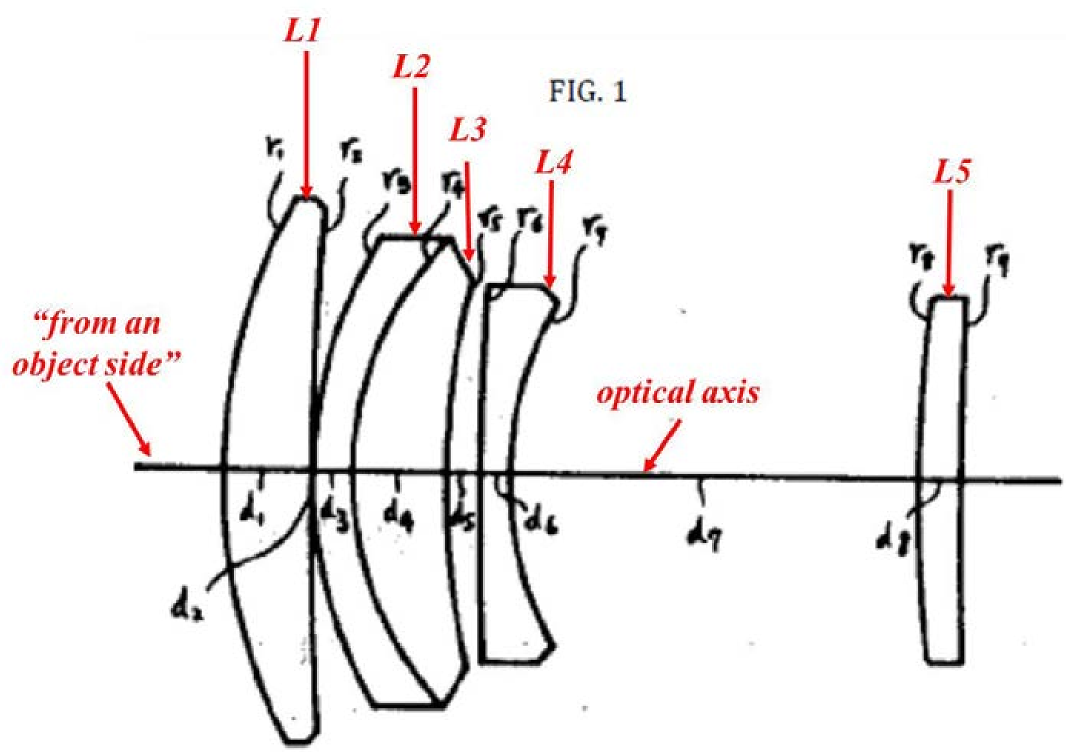
[5.3] ***wherein the second lens includes five lens elements along an optical axis starting from an object starting with a first lens element with positive power, wherein the five lens elements further include a second lens element with negative power, a fourth lens element with negative power and a fifth lens element,***

83. Golan in view of Kawamura renders obvious that the second lens includes five lens elements along an optical axis starting from an object starting with a first lens element with positive power, wherein the five lens elements further include a second lens element with negative power, a fourth lens element with negative power and a fifth lens element.

84. **First**, each of example 1 of FIGS. 1-2, example 2 of FIGS. 3-4, example 3 of FIGS. 5-6, and example 4 of FIGS. 7-8 of Kawamura teaches a fixed focal length tele lens that includes five lens elements along an optical axis starting from an object starting with a first lens element with positive power, wherein the five lens elements further include a second lens element with negative power, a fourth lens element with negative power and a fifth lens element. While the analysis below uses example 1 as an example, similar analysis applies to examples 2-4 of Kawamura.

85. Specifically, as shown in annotated FIG. 1 of Kawamura below, Kawamura teaches a lens system referred to as example 1 including five lens elements, (annotated as L1 through L5) along an optical axis starting from an

object. Kawamura, FIG. 1, 1, 5. Kawamura describes that a "telephoto lens of a four-group, **five-lens configuration**" that includes, "**in order from an object side**, a **first** lens, which is a **positive** meniscus lens that is convex toward the object side; a **second** lens and a **third** lens, which are a laminated positive meniscus lens of **a negative meniscus lens** and **positive meniscus lens** having a lamination surface that is convex toward the object side; a **fourth lens, which is a negative lens** having a rear surface with a large curvature that is concave toward an image-surface side; and a fifth lens, which is a positive lens." (APPL-1007), Kawamura, 1. A POSITA would have understood that Kawamura's telephoto lens includes a doublet made up of two simple lenses L2 (Kawamura's second lens) and L3 (Kawamura's third lens) paired together (e.g., cemented together).



(APPL-1007), Kawamura, FIG. 1, annotated

86. Kawamura's first lens L1 of example 1, which is the first of lenses L1 through L5 along an optical axis starting from an object, teaches "*a first lens element with positive power*" as claimed. Specifically, Kawamura explains that its telephoto lens includes "in order **from an object side**, a **first** lens, which is a **positive** meniscus lens that is convex toward the object side," and therefore, teaches a first lens element L1 with positive power. (APPL-1007), Kawamura, 1.

87. Kawamura's second lens L2 of example 1, which is the second lens of lenses L1 through L5 along the optical axis starting from an object, teaches "*a second lens element with negative power*" as claimed. Specifically, Kawamura explains that its telephoto lens includes "in order **from an object side**, … a **second** lens and a third lens, which are a laminated positive meniscus lens of a **negative** meniscus lens and **positive** meniscus lens having a lamination surface that is convex toward the object side." (APPL-1007), Kawamura, 1. As such, a POSITA would have understood that example 1 of Kawamura teaches that second lens L2 is "a **negative** meniscus lens" with negative power, third lens L3 is a "**positive** meniscus lens" with positive power, and lens elements L2 and L3 are combined to form "a laminated positive meniscus lens." (APPL-1007), Kawamura, 1.

88. Kawamura's fourth lens L4 of example 1, which is the fourth lens of lenses L1 through L5 along the optical axis starting from an object, teaches "*a fourth*

lens element with negative power" as claimed. Specifically, Kawamura explains that its telephoto lens includes "in order from an object side, … a **fourth** lens, which is a **negative** lens having a rear surface with a large curvature that is concave toward an image-surface side," and therefore teaches a fourth lens element with negative power. (APPL-1007), Kawamura, 1.

89. Kawamura's fifth lens L5 of example 1, which is the fifth lens of lenses L1 through L5 along the optical axis starting from an object, teaches "*a fifth lens element*" as claimed. Specifically, Kawamura explains that fifth lens L5 "is a positive lens," and therefore has positive power. (APPL-1007), Kawamura, 1.

90. Similar to the analysis of example 1 of Kawamura, as illustrated in FIGS. 3, 5, and 7 of Kawamura and corresponding tables of corresponding lens data respectively, each of examples 2-4 of Kawamura includes five lens elements along an optical axis starting from an object starting with a first lens element with positive power, wherein the five lens elements further include a second lens element with negative power, a fourth lens element with negative power and a fifth lens element. (APPL-1007), Kawamura, FIGS. 3, 5, and 7, 1-5.

91. A POSITA would have been motivated to apply Kawamura's teachings of a telephoto lens with the five lens elements configuration in the fixed focal length tele lens 120 of the digital camera of Golan, to achieve the benefit of "a compactness of an overall length to a conventional level of a telephoto ratio of

about 0.96 to 0.88," "an excellent image-formation performance due to favorably correcting spherical aberration of both a reference wavelength and color" with "decreasing chromatic aberration in magnification." (APPL-1007), Kawamura, 1. *See also* Ground 1: Reasons to Combine Golan and Kawamura.

92. Accordingly, in the zoom digital camera of Golan and Kawamura, a zoom control subsystem 100 includes a tele lens 120 having a five lens element configuration as taught by Kawamura, which renders obvious that "*the second lens includes five lens elements along an optical axis starting from an object starting with a first lens element with positive power, wherein the five lens elements further include a second lens element with negative power, a fourth lens element with negative power and a fifth lens element*" as claimed.

[5.4] *wherein a largest distance between consecutive lens elements along the optical axis is a distance between the fourth lens element and the fifth lens element, and*

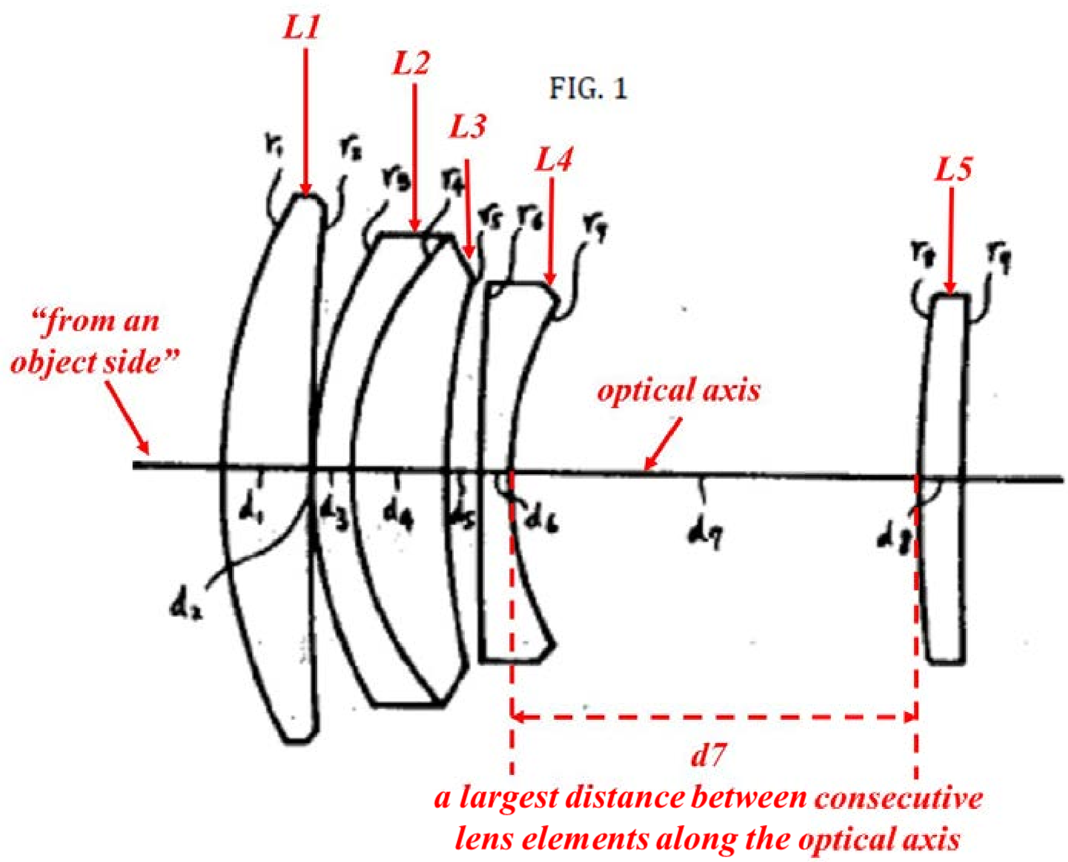
93. Golan in view of Kawamura renders obvious that a largest distance between consecutive lens elements along the optical axis is a distance between the fourth lens element and the fifth lens element.

94. **First**, as discussed in [5.3], in combination of Golan and Kawamura, the digital camera includes a telephoto lens including five lens elements as taught by Kawamura.

95. **Second**, Kawamura teaches that, in its telephoto lens, a largest

distance between consecutive lens elements along the optical axis is a distance between the fourth lens element and the fifth lens element.

96. Specifically, as shown in annotated FIG. 1 of Kawamura below, in Kawamura's lens system example 1, distance d2 is between consecutive lens elements L1 and L2. Because lens elements L2 and L3 are combined to form a composite lens, the distance between lens elements L2 and L3 is close to zero. Further, distance d5 is a distance between the third lens element L3 and the fourth lens element L4, and d7 is a distance between the fourth lens element L4 and the fifth lens element L5.



(APPL-1007), Kawamura, FIG. 1, annotated

97. As shown in annotated FIG. 1 of Kawamura, distance d7 between fourth and fifth lens elements L4 and L5 is the largest distance between consecutive lens elements along the optical axis, among distance d2, a distance close to 0, distance d5, and distance d7. This is confirmed by the annotated Example 1 table of Kawamura below, where distance d7 has a value of "41.80," which is the largest distance between consecutive lens elements along the optical axis among distance d2 ("0.20"), distance d5 ("3.50"), and distance d7 ("41.80").

1 : 4.1 $F = 200.079$ $\omega = 12.3°$

NO.	r	d	N	ν
1	57.091	9.00	1.60311	60.7
2	330.000	0.20		
3	45.039	4.00	1.67270	32.1
4	33.450	9.60	1.48749	70.1
5	81.000	3.50		
6	387.380	3.00	1.57501	41.5
7	34.361	41.80		
8	146.228	4.34	1.74950	35.3
9	552.040			

a largest distance between consecutive lens elements along the optical axis d7

$F_{1\cdot2\cdot3} = 74.912$

$F_{1\cdot2\cdot3\cdot4} = 356.466$

$d_1 + d_2 + d_3 + d_4 + d_5 + d_6 = 29.3$

(APPL-1007), Kawamura, 3, table for example 1, annotated

98. Similar to the analysis of example 1 of Kawamura, in each of examples 2-4 of Kawamura, distance d7 between fourth and fifth lens elements L4 and L5 is the largest distance between consecutive lens elements along the optical axis. Such a largest distance between consecutive lens elements along the optical axis remains a largest distance after scaling.

99. Accordingly, in the zoom digital camera of Golan and Kawamura, a zoom control subsystem 100 includes a tele lens 120 having a five lens element configuration as taught by Kawamura, where distance d7 between fourth and fifth lens elements L4 and L5 is the largest distance between consecutive lens elements along the optical axis, which renders obvious that "*a largest distance between consecutive lens elements along the optical axis is a distance between the fourth lens element and the fifth lens element*" as claimed.

[5.5] ***wherein a ratio of a total track length (TTL) to effective focal length (EFL) of the second lens is smaller than 1.***

100. Golan in view of Kawamura renders obvious that a ratio of a total track length (TTL) to effective focal length (EFL) of the second lens is smaller than 1.

101. **First**, as discussed in [5.3], in the combination of Golan and Kawamura, the digital camera includes a telephoto lens including five lens elements as taught by Kawamura.

102. **Second**, Kawamura teaches that its telephoto lens has a ratio of a total track length (TTL) to effective focal length (EFL) of the second lens is smaller than 1.

103. Specifically, Kawamura's telephoto lens "keeps a compactness of an overall length to a conventional level of a telephoto ratio of about 0.96 to 0.88." (APPL-1007), Kawamura, 1. A POSITA would have understood that a telephoto ratio of Kawamura is a ratio of total track length (TTL)/effective focal length (EFL). *See, e.g.*, (APPL-1006), Smith, 169 ("The arrangement shown in Fig. 10.1, with a positive component followed by a negative component, can produce a compact system with an **<u>effective focal length F</u> that is longer than <u>the overall length L</u> of the lens**. **The ratio of L/F is called the <u>telephoto ratio</u>**, and a lens for which this ratio is less than unit is classified as a telephoto lens."). A POSITA would understand the "telephoto ratio" of Smith is the same as the claimed TTL/EFL ratio, since TTL and L both refer to the overall length of the lens (*see* (APPL-1008), Chen, 3:24-26), and F is described as the effective focal length of the lens system. (APPL-1006), Smith, 169.

104. Kawamura describes that its telephoto lens satisfies the following conditions, which achieves the telephoto ratio less than one (e.g., "about 0.96 to 0.88"). (APPL-1007), Kawamura, 1-2.

(1) $0.3F < F_{1 \cdot 2 \cdot 3} < 0.5F$

(2) $1.0F < F_{1 \cdot 2 \cdot 3 \cdot 4} < 2.5F$

(3) $0.1F < d_1 + d_2 + d_3 + d_4 + d_5 + d_6 < 0.2F$

(4) $0.1F < d_7 < 0.3F$

(5) $30 < \nu_4 < 50$

(6) $0.1F < r_4 < 0.25F$

(7) $0.05 < n_2 - n_3 < 0.3$

(8) $5 < \nu_3 - \nu_2 < 50$

where F is the "focal length of overall system," $F_{1,2,\ldots i}$ refers to "composite focal length to ith lens," and d_j refers to "jth surface interval." (APPL-1007), Kawamura, 2.

105. Specifically, Kawamura explains that condition (1) "is a condition that, in connection with conditions (2) and (3), **indicates an allocation of a focal length necessary to set a telephoto ratio to about 0.96 to 0.88** and form a framework of the telephoto lens that favorably corrects aberration." (APPL-1007), Kawamura, 2.

106. Furthermore, Kawamura discloses lens prescription data for examples 1-4 supporting that in each of examples 1-4 has a TTL/EFL ratio that is smaller than 1.0. I have used lens design software ZEMAX to perform lens analysis of each of examples 1-4 of Kawamura, and the results are attached as an Appendix. Using the lens prescription tables of Kawamura, the lens design

software ZEMAX, and the standard wavelength of 587.56 nm (d-line in Kawamura), I have confirmed that each of the examples 1-4 has a ratio of a total track length (TTL) to effective focal length (EFL) is smaller than 1. *See* Appendix, A-D. The table below summarizes the results of those ZEMAX calculations. Such a ratio of a total track length (TTL) to effective focal length (EFL) remains unchanged by scaling.

	TTL	**EFL**	**TTL/EFL**
Example 1	187.985 mm	200.079 mm	0.939
Example 2	185.891 mm	199.419 mm	0.932
Example 3	179.068 mm	199.692 mm	0.896
Example 4	179.086 mm	199.766 mm	0.896

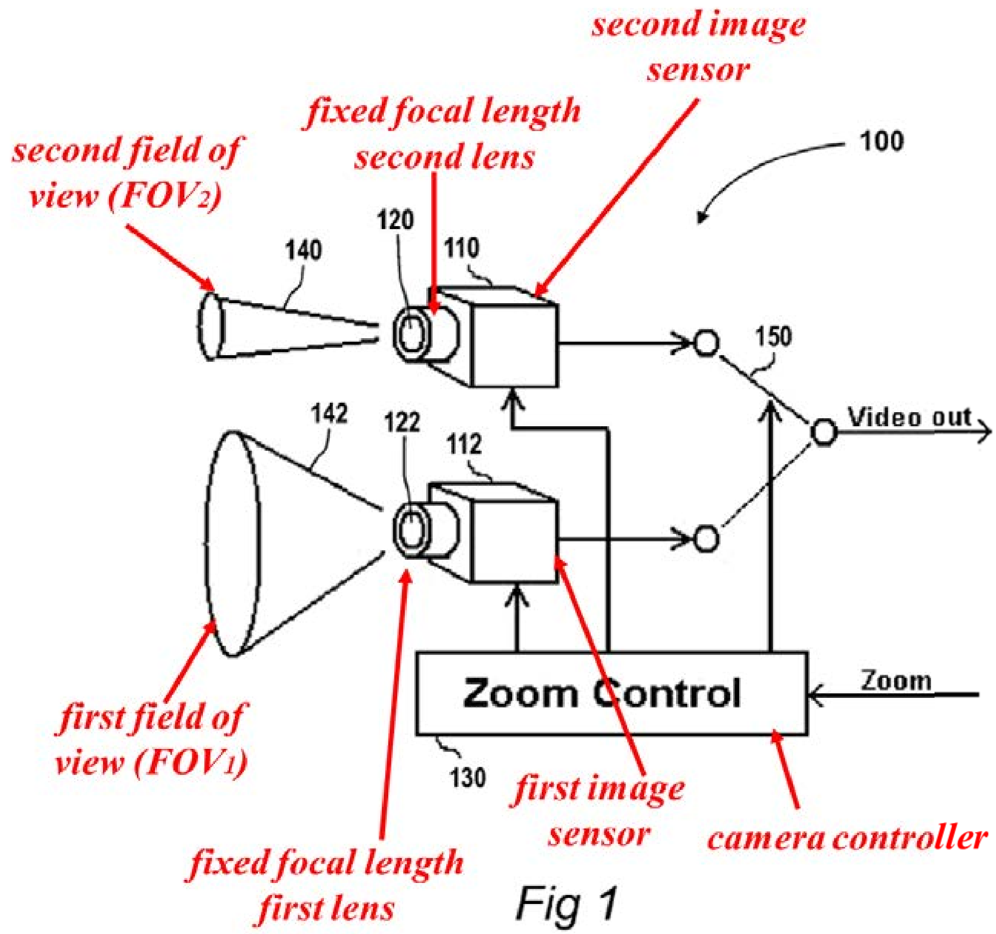
107. Accordingly, in the zoom digital camera of combined Golan and Kawamura, a zoom control subsystem 100 includes a tele lens 120 having a five lens element configuration as taught by Kawamura, where a ratio of a total track length (TTL) to effective focal length (EFL) of the tele lens 120 is smaller than 1, which renders obvious that "*a ratio of a total track length (TTL) to effective focal length (EFL) of the second lens is smaller than 1*" as claimed.

5. Claim 6

[6.1] ***The zoom digital camera of claim 5, further comprising a camera controller operatively coupled to the first and second imaging sections,***

108. Golan combined with Kawamura renders obvious a camera controller operatively coupled to the first and second imaging sections.

109. Specifically, Golan teaches a zoom control sub-system 100 of a digital camera includes a camera controller including a zoom control circuit 130 coupled to the first and second imaging sections. As shown in annotated Fig. 1 below, Golan describes that "zoom control circuit 130 receives a required zoom from an operator of the image acquisition system, and selects the relevant image sensor (110 and 112) by activating image sensor selector 150 position." (APPL-1005), Golan, [0036].



(APPL-1005), Golan, FIG. 1, annotated

110. Golan further teaches that the zoom control circuit 130 "resample[es] the acquired image frame to the requested zoom." (APPL-1005), Golan, Fig. 2, [0048]. Specifically, zoom control circuit 130 "computes the zoom factor between the fixed zoom of the selected image acquisition device and the requested zoom," and "performs electronic zoom on the acquired image frame to meet the requested zoom" based on the computed factor. (APPL-1005), Golan, [0049].

111. As such, Golan's zoom control circuit 130 is coupled to first and

second imaging sections to select one of the first and second imaging sections based on a requested zoom, receives an image frame acquired by the selected imaging section, and performs digital zoom to the acquired image frame to obtain an acquired image frame with said requested zoom. (APPL-1005), Golan, claim 1.

112. Therefore, in the combination of Golan and Kawamura, zoom control sub-system 100 includes a camera controller including a zoom control circuit 130 coupled to the first and second imaging sections for receiving a requested zoom and provide an acquired image frame with the requested zoom, which teaches "*a camera controller operatively coupled to the first and second imaging sections*" as recited in the claim.

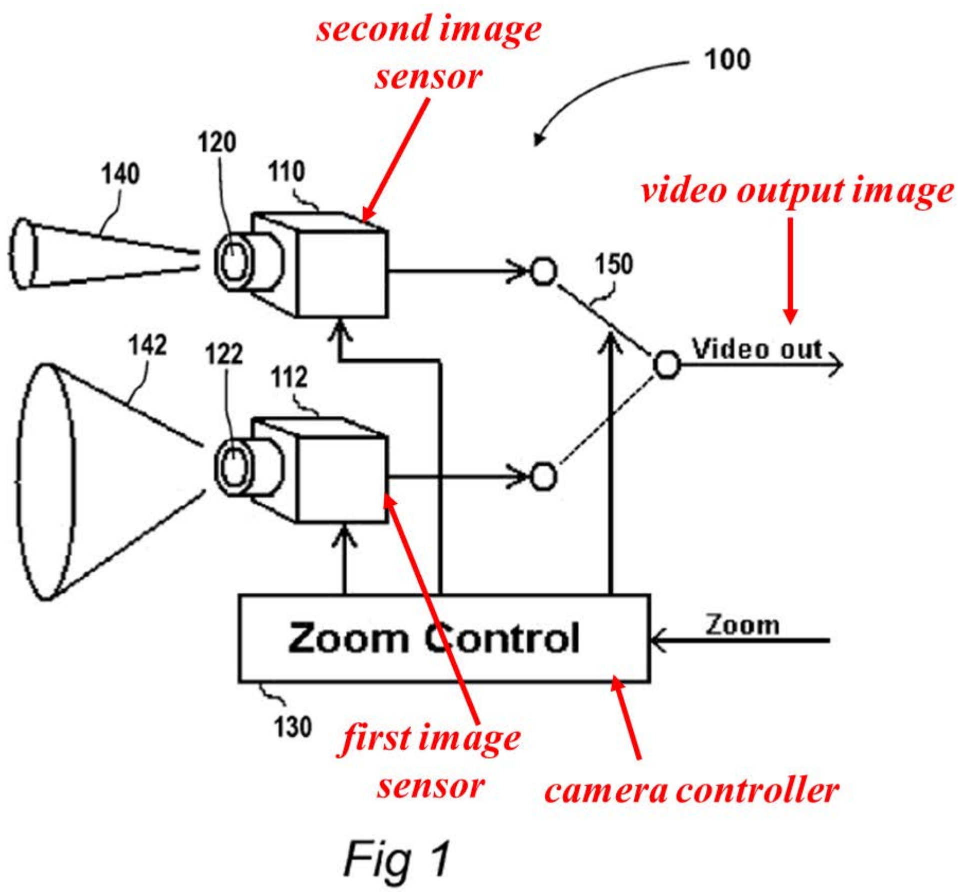
[6.2] ***the camera controller configured to provide video output images with a smooth transition when switching between a lower zoom factor (ZF) value and a higher ZF value or vice versa.***

113. Golan combined with Kawamura renders obvious that the camera controller is configured to provide video output images with a smooth transition when switching between a lower zoom factor (ZF) value and a higher ZF value or vice versa.

114. **First**, Golan discloses providing that a camera controller of its zoom control sub-system 100 is configured "*to provide video output images*" as recited in the claim.

115. Specifically, as shown in annotated Fig. 1 of Golan below, control

sub-system 100 provides video output images, where "zoom control 130 performs **electronic zoom** on the acquired image frame to meet the requested zoom," and "[d]igital zoom is a method for narrowing the apparent angle of view of a digital still or **video image**." (APPL-1005), Golan, Fig. 1; [0003]; [0049]. *See also* (APPL-1005), Golan, [0004] (describing providing "**video streams** (such as PAL, NTSC, SECAM, 656, etc.)").



(APPL-1005), Golan, FIG. 1, annotated

116. Second, Golan discloses that its zoom control sub-system 100 is configured "*to provide video output images with a smooth transition*" as recited in

the claim when switching between two adjacently disposed image sensors, wide image sensor 112 (first image sensor) and tele image sensor 110 (second image sensor).

117. Specifically, Golan teaches a zoom control subsystem 100 providing "**<u>continuous electronic zoom capabilities with uninterrupted imaging</u>**, performed by an image acquisition system having multiple image sensors, each with a fixed and preferably different FOV," and such "**continuous electronic zoom with uninterrupted imaging is <u>also maintained when switching back and forth between adjacently disposed image sensors</u>**." (APPL-1005), Golan, [0040].

118. Because Golan teaches a transition between Wide image and Tele image when switching back and forth between adjacently disposed image sensors that has "uninterrupted imaging," it teaches a transition with a continuous image change. (APPL-1005), Golan, [0040]. As such, Golan's "continuous electronic zoom with uninterrupted imaging" that is "maintained" when switching between Wide and Tele sensors teaches "*smooth transition*" or "transition with a reduced discontinuous image change" as claimed and construed in VI.A.

119. Golan teaches that electronic calibration to align image sensors may be used to achieve the smooth transition. *See e.g.*, (APPL-1005), Golan, Abstract ("**<u>alignment</u> between the wide image sensor array and the tele image sensor**

array is computed, to facilitate continuous electronic zoom with uninterrupted imaging, when switching back and forth between the wide image sensor array and the tele image sensor array.”). As shown in FIG. 2 below, in Golan, at step 220 of a continuous zoom process 200 performed on zoom control sub-system 100, “electronically calibrating is performed to determine the <u>**alignment offsets between wide image sensor array 110 and tele image sensor array 112**</u>,” which “yields an X-coordinate offset and a Y-coordinate offset of the correlation between wide image sensor array 110 and tele image sensor array112.” (APPL-1005), Golan, [0041], [0045]. Those coordinate offsets are computed in high accuracy (e.g., “sub-pixel accuracy”). (APPL-1005), Golan, [0045].

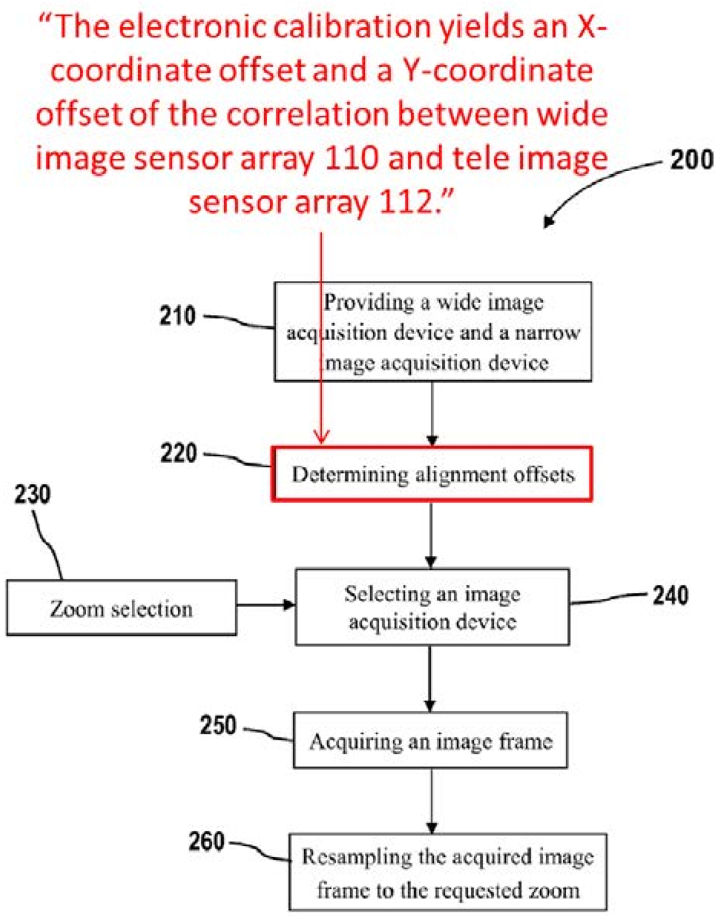


Fig 2

(APPL-1005), Golan, FIG. 2, annotated

120. A POSITA would have understood that in Golan, by providing "**continuous electronic zoom with uninterrupted imaging, when switching back and forth between the wide image sensor array and the tele image sensor array**" using calibrated alignment offsets between Wide and Tele sensors with high accuracy (e.g., "sub-pixel accuracy"), ((APPL-1005), Golan, Abstract, [0045]), jumps (discontinuousness) in video output images when switching

between Wide and Tele sensors (and their corresponding point of views) are minimized.

121. **Third**, Golan's switching back and forth between adjacently disposed image sensors, a wide image sensor 112 (first image sensor) and a tele image sensor 110 (second image sensor), teaches "*switching between a lower zoom factor (ZF) value and a higher ZF value or vice versa*" as recited in the claim.

122. Specifically, Golan teaches that the wide image sensor 112 (first image sensor) is used to provide a video output image having a lower zoom (ZF) value, and a tele image sensor 110 (second image sensor) is used to provide a video output image having a higher ZF value, and as such, switching between wide and tele image sensors teaches switching between video output images having a lower ZF value and a higher ZF value.

123. Specifically, with reference to FIG. 1 above, Golan describes that an "object 20 is viewed from both tele image sensor 110 and wide image sensor 112, whereas the object is **<u>magnified</u> in** tele image sensor 110 with respect to wide image sensor 112, **by a predesigned factor**." (APPL-1005), Golan, [0037]. A POSITA would have understood that Golan's predesigned factor for magnification teaches a relative magnification ratio of an object in the tele image sensor 110 with respect to the wide image sensor 112, which is used to determine a switch zoom point between Wide and Tele sensors (and corresponding images) for "light weight

electronic zoom and a large lossless zooming range." (APPL-1005), Golan, [0007]. For example, Golan teaches "switching between the image sensors provide a lossless electronic zoom of 6^2=36." (APPL-1005), Golan, [0009]. A POSITA would have understood that lossless zooming range of 36 in Golan's example is provided by switching between Wide and Tele sensors at a switch zoom factor depending on the relative magnification ratio of Tele image to Wide image, e.g., by switching at a switch zoom factor equal to 6, performing digital zoom to Wide image for a requested zoom factor between 1 and 6, and performing digital zoom to Tele image for a requested zoom factor between 6 and 36. As such, in Golan, the tele image sensor 110 corresponds to a higher ZF value (for providing an image with a higher magnification, e.g., between 6 and 36) and the wide image sensor 112 corresponds to a lower ZF value (for providing an image with a lower magnification, e.g., between 1 and 6). Further, Golan teaches electronic zooming on either of the sensors, and a POSITA would have understood performing electronic zoom on either sensor also teaches switching between a lower zoom factor to a higher zoom factor, and vice versa.

124. Golan describes that "zoom control circuit 130 receives a required zoom from an operator of the image acquisition system, and selects the relevant image sensor (110 and 112) by activating image sensor selector 150 position." (APPL-1005), Golan, [0036]. As shown in annotated FIG. 2 of Golan below,

Golan teaches at step 240, selecting an imaging acquisition device (110 or 112) based on the requested zoom "having a zoom more proximal to the requested zoom." (APPL-1005), Golan, [0047]. As such, Golan teaches that for a requested zoom below a switch zoom factor (e.g., a magnification ratio of tele image sensor 110 with respect to the wide image sensor 112) (corresponds to "*a lower zoom factor (ZF) value*" as claimed), the wide image sensor 112 is selected to provide the acquired image. Similarly, in Golan, for a requested zoom above the switch zoom factor (corresponds to "*a higher ZF value*" as claimed), the wide image sensor 112 is selected to provide the acquired image.

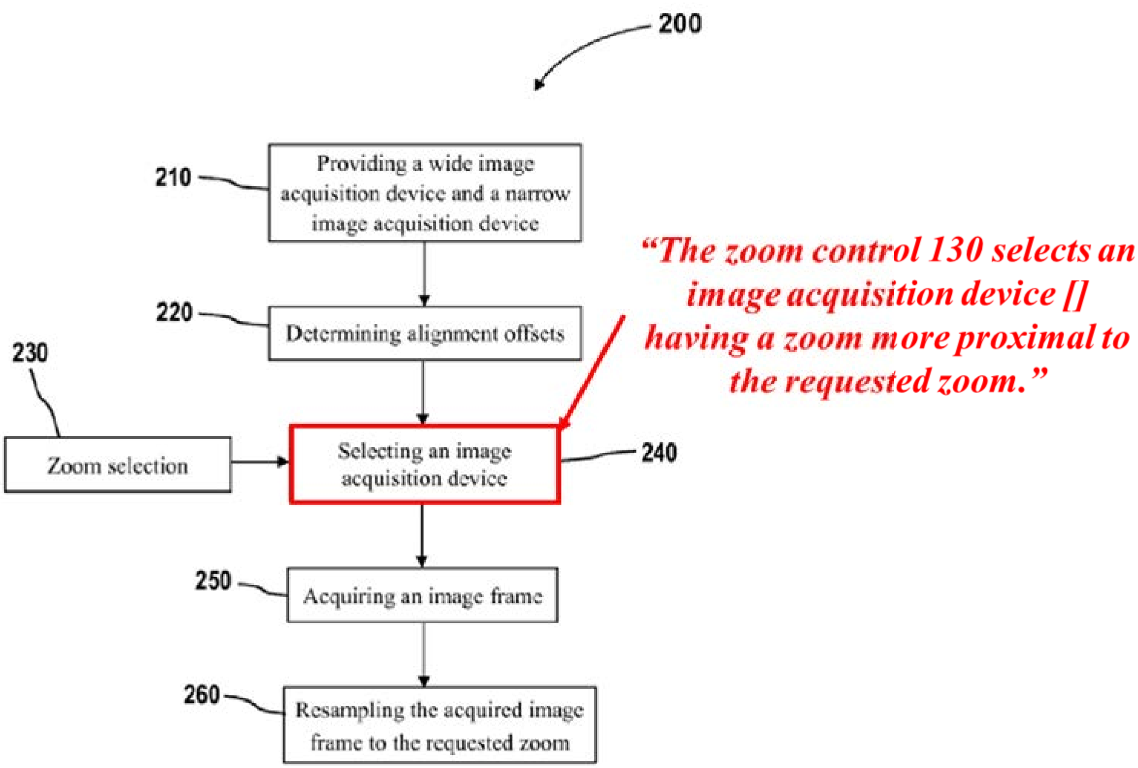


Fig 2

(APPL-1005), Golan, FIG. 2, annotated

125. Golan further teaches that the zoom control circuit 130 "resample[es] the acquired image frame to the requested zoom," and provides that resampled image as the video output image. (APPL-1005), Golan, FIG. 2, [0048]. As such, Golan's switching back and forth between adjacently disposed image sensors, a wide image sensor 112 (first image sensor) for providing an output video image at a lower ZF, and a tele image sensor 110 (second image sensor) for providing an output video image at a higher ZF, teaches "*switching between a lower zoom factor (ZF) value and a higher ZF value or vice versa*" as recited in the claim.

126. As such, because Golan discloses that its zoom control sub-system 100 is configured "*to provide video output images with a smooth transition*" when switching between two adjacently disposed image sensors, and because Golan's switching between two adjacently disposed image sensors teaches "*switching between a lower zoom factor (ZF) value and a higher ZF value or vice versa*" as recited in the claim, Golan teaches that its zoom control sub-system 100 is configured "*to provide video output images with a smooth transition when switching between a lower zoom factor (ZF) value and a higher ZF value or vice versa"* as recited in the claim.

127. A POSITA would have understood that in the combination of Golan and Kawamura, for providing continuous zoom video output images with a smooth

transition when switching, numerous camera design and image processing methods were well known in the art and may be implemented in addition to electronic calibration disclosed in Golan. *See, e.g.*, (APPL-1015), Konno, 14 ("a parallax between the first and second imaging optical systems LN1 and LN2, which is generated depending on the shooting distance" may be compensated "by slightly inclining one of the first and second imaging optical systems LN1 and LN2" or by an "optical camera shake compensation function"); (APPL-1012), Scarff, 4:12-26 (describing that maintaining similar characteristics in two images (e.g., "brightness and contrast," "amplification," "background noise," "artifacts ... due to subject motion," "depth of field") captured by two image sensors makes "transitions between the two images [captured by two image sensors] more acceptable to the user"); (APPL-1010), Ahiska, 9:44-10:5 (by matching image properties including for example brightness, exposure levels, color between two images from two image sensors to achieve "transition between the master view and the slave view as seamlessly as possible to create the quality of a continuous zoom function").

128. Accordingly, in the digital camera of Golan and Kawamura, zoom control sub-system 100 includes a camera controller including a zoom control circuit 130 configured to provide video output images with continuous electronic zoom with uninterrupted imaging when switching back and forth between the Wide sensor (providing video image at a lower ZF value less than switch zoom factor) and

Tele sensor (providing video image at a higher ZF value greater than switch zoom factor). Therefore, Golan combined with Kawamura renders obvious that "*the camera controller configured to provide video output images with a smooth transition when switching between a lower zoom factor (ZF) value and a higher ZF value or vice versa*" as recited.

VIII. DECLARATION

129. I declare that all statements made herein of my own knowledge are true, that all statements made on information and belief are believed to be true, and that these statements were made with knowledge that willful false statements so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code.

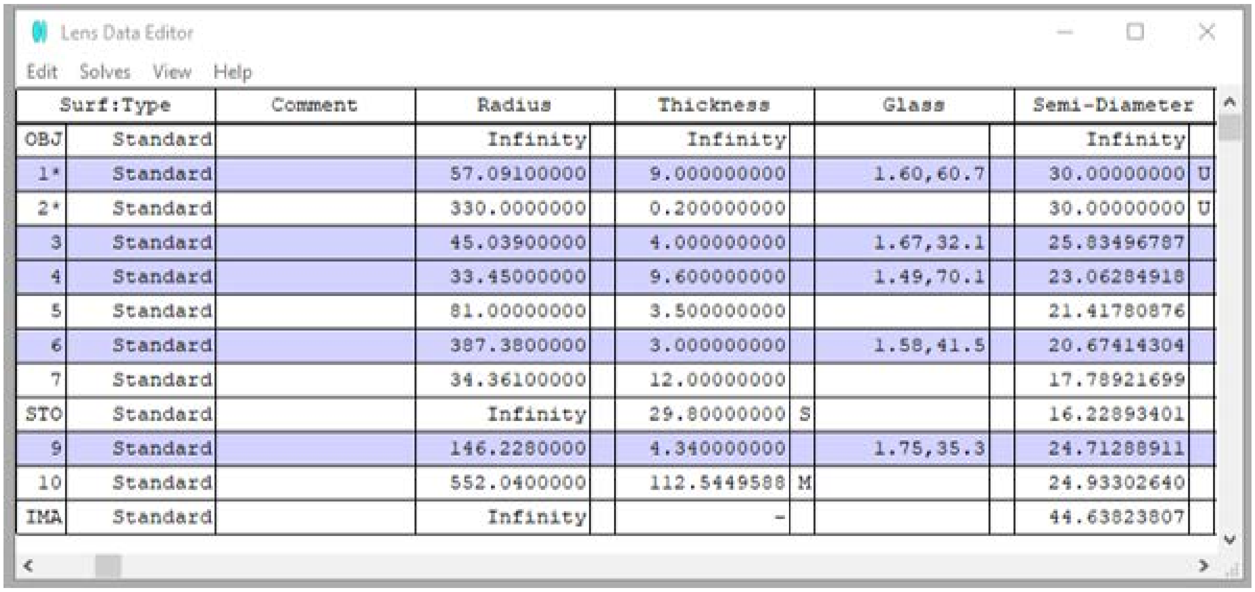
Dated: February 5, 2020

José Sasián 02/05/2020

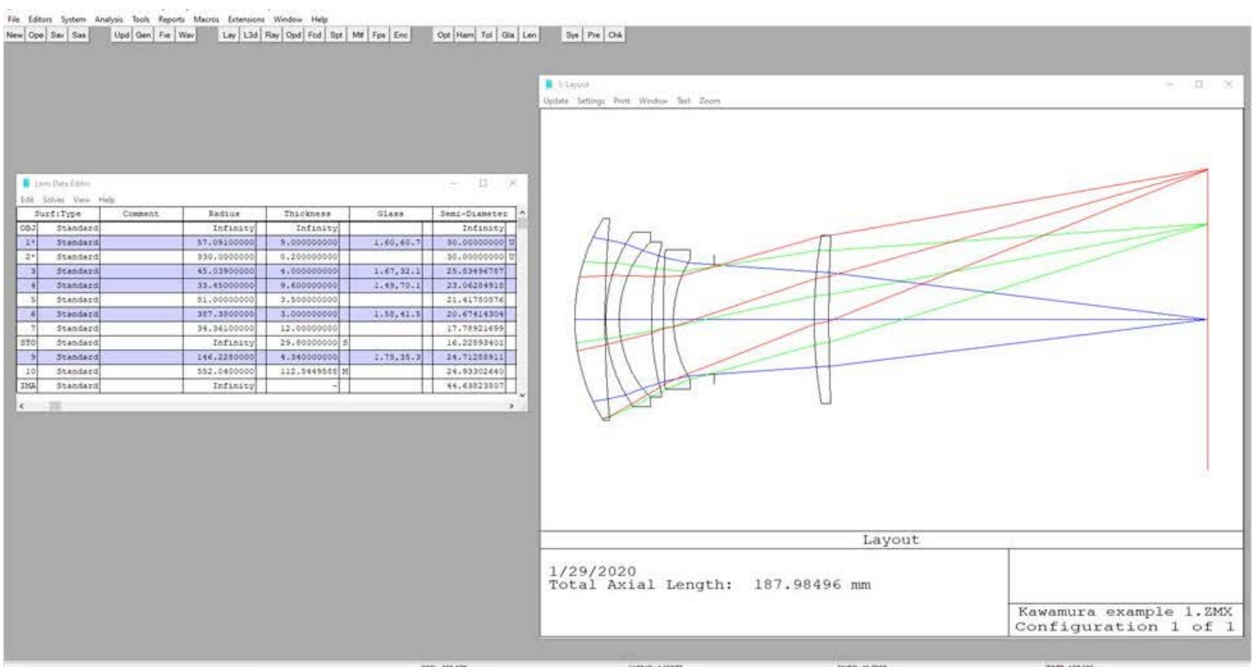
José Sasián

IX. APPENDIX

A. Analysis of Kawamura Example 1 as input in ZEMAX lens design software (February 14, 2011 version)


Lens Data Editor
Edit Solves View Help

Surf:Type		Comment	Radius		Thickness		Glass		Semi-Diameter	
OBJ	Standard		Infinity		Infinity				Infinity	
1*	Standard		57.09100000		9.000000000		1.60,60.7		30.00000000	U
2*	Standard		330.0000000		0.200000000				30.00000000	U
3	Standard		45.03900000		4.000000000		1.67,32.1		25.83496787	
4	Standard		33.45000000		9.600000000		1.49,70.1		23.06284918	
5	Standard		81.00000000		3.500000000				21.41780876	
6	Standard		387.3800000		3.000000000		1.58,41.5		20.67414304	
7	Standard		34.36100000		12.00000000				17.78921699	
STO	Standard		Infinity		29.80000000	S			16.22893401	
9	Standard		146.2280000		4.340000000		1.75,35.3		24.71288911	
10	Standard		552.0400000		112.5449588	M			24.93302640	
IMA	Standard		Infinity		-				44.63823807	



EFL
"EFFL:200.079"

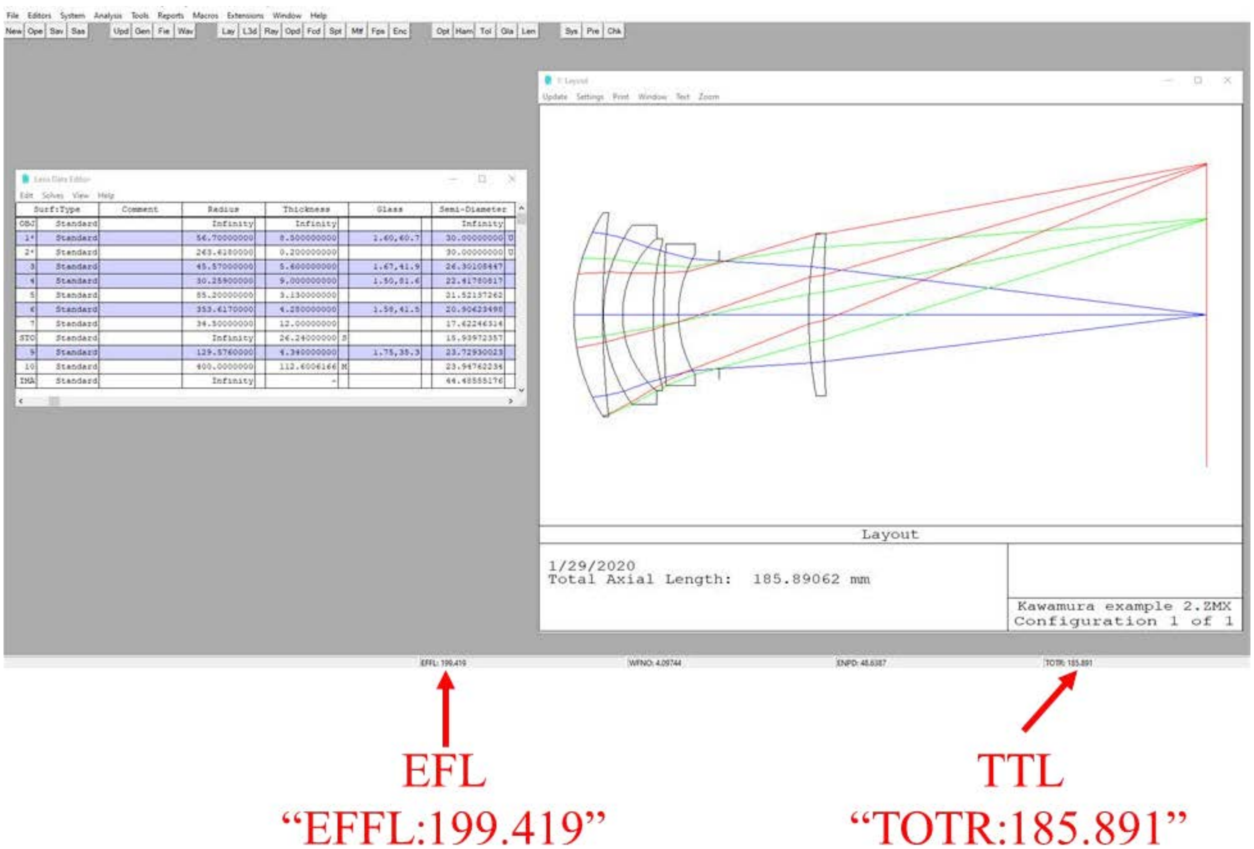
TTL
"TOTR:187.985"

B. Analysis of Kawamura Example 2 as input in ZEMAX lens design software

Lens Data Editor

Edit Solves View Help

Surf:Type		Comment	Radius		Thickness		Glass		Semi-Diameter	
OBJ	Standard		Infinity		Infinity				Infinity	
1*	Standard		56.70000000		8.500000000		1.60,60.7		30.00000000	U
2*	Standard		263.6180000		0.200000000				30.00000000	U
3	Standard		45.57000000		5.600000000		1.67,41.9		26.30108447	
4	Standard		30.25900000		9.000000000		1.50,81.6		22.41780817	
5	Standard		85.20000000		3.130000000				21.52137262	
6	Standard		353.6170000		4.280000000		1.58,41.5		20.90623498	
7	Standard		34.50000000		12.00000000				17.62246314	
STO	Standard		Infinity		26.24000000	S			15.93972357	
9	Standard		129.5760000		4.340000000		1.75,35.3		23.72930023	
10	Standard		400.0000000		112.6006166	M			23.94762234	
IMA	Standard		Infinity		-				44.48555176	

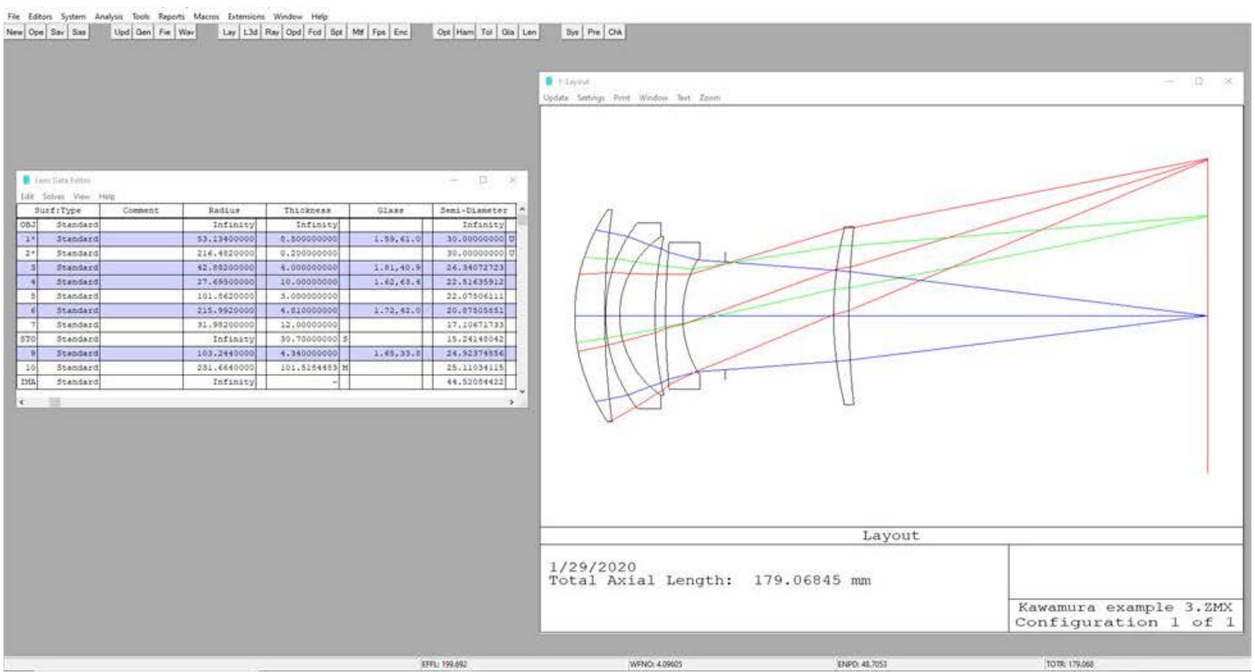


C. Analysis of Kawamura Example 3 as input in ZEMAX lens design

Lens Data Editor

Edit Solves View Help

	Surf:Type	Comment	Radius		Thickness		Glass		Semi-Diameter	
OBJ	Standard		Infinity		Infinity				Infinity	
1*	Standard		53.13400000		8.500000000		1.59,61.0		30.00000000	U
2*	Standard		216.4820000		0.200000000				30.00000000	U
3	Standard		42.88200000		4.000000000		1.81,40.9		26.34072723	
4	Standard		27.69500000		10.00000000		1.62,63.4		22.51635912	
5	Standard		101.8620000		3.000000000				22.07506111	
6	Standard		215.9920000		4.810000000		1.72,42.0		20.87505851	
7	Standard		31.98200000		12.00000000				17.10671733	
STO	Standard		Infinity		30.70000000	S			15.24148042	
9	Standard		103.2440000		4.340000000		1.65,33.8		24.92374856	
10	Standard		231.6640000		101.5184483	M			25.11034115	
IMA	Standard		Infinity		-				44.52084422	



EFL
"EFFL:199.692"

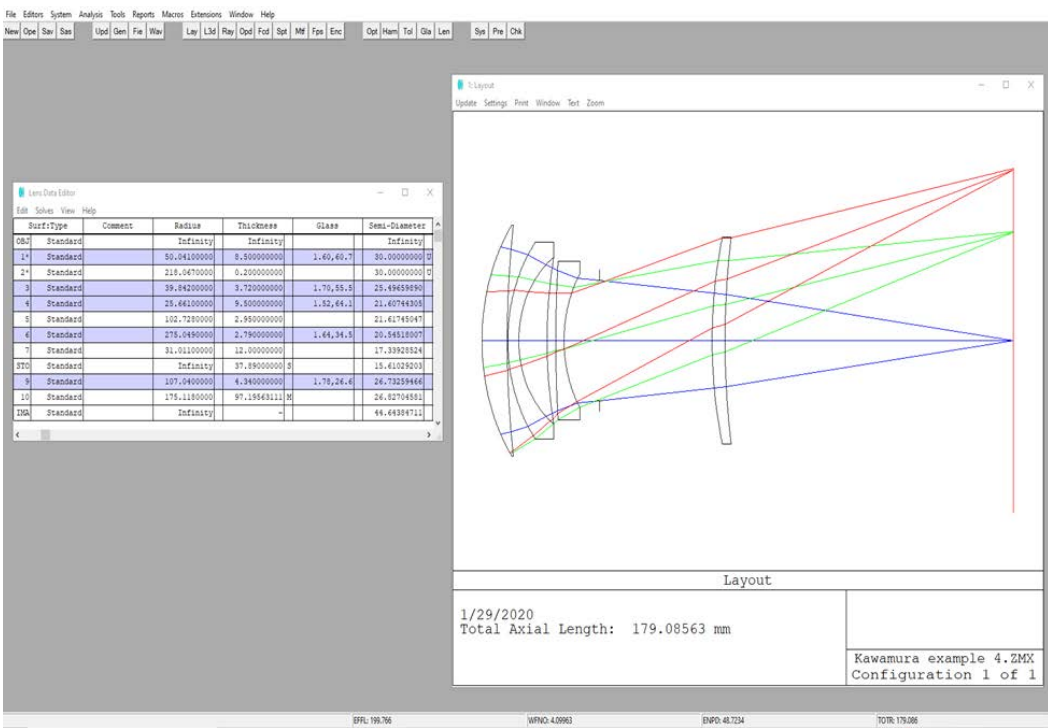
TTL
"TOTR:179.06845"

D. Analysis of Kawamura Example 4 as input in ZEMAX lens design software

Lens Data Editor

Edit Solves View Help

Surf	Type	Comment	Radius	Thickness	Glass	Semi-Diameter
OBJ	Standard		Infinity	Infinity		Infinity
1*	Standard		50.04100000	8.500000000	1.60,60.7	30.00000000 U
2*	Standard		218.0670000	0.200000000		30.00000000 U
3	Standard		39.84200000	3.720000000	1.70,55.5	25.49659890
4	Standard		25.66100000	9.500000000	1.52,64.1	21.60744305
5	Standard		102.7280000	2.950000000		21.61745047
6	Standard		275.0490000	2.790000000	1.64,34.5	20.54518007
7	Standard		31.01100000	12.00000000		17.33928524
STO	Standard		Infinity	37.89000000 S		15.61029203
9	Standard		107.0400000	4.340000000	1.78,26.6	26.73259466
10	Standard		175.1180000	97.19563111 M		26.82704581
IMA	Standard		Infinity	-		44.64384711



EFL
"EFFL:199.766"

TTL
"TOTR:179.086"

US 20120026366A1

(19) **United States**
(12) **Patent Application Publication**
Golan et al.
(10) **Pub. No.: US 2012/0026366 A1**
(43) **Pub. Date: Feb. 2, 2012**

(54) **CONTINUOUS ELECTRONIC ZOOM FOR AN IMAGING SYSTEM WITH MULTIPLE IMAGING DEVICES HAVING DIFFERENT FIXED FOV**

(75) Inventors: **Chen Golan**, Ein Vered (IL); **Boris Kipnis**, Tel-aviv (IL)

(73) Assignee: **Nextvision Stabilized Systems Ltd.**, Raanana (IL)

(21) Appl. No.: **13/262,842**

(22) PCT Filed: **Apr. 6, 2010**

(86) PCT No.: **PCT/IL10/00281**

§ 371 (c)(1), (2), (4) Date: **Oct. 4, 2011**

Related U.S. Application Data

(60) Provisional application No. 61/167,226, filed on Apr. 7, 2009.

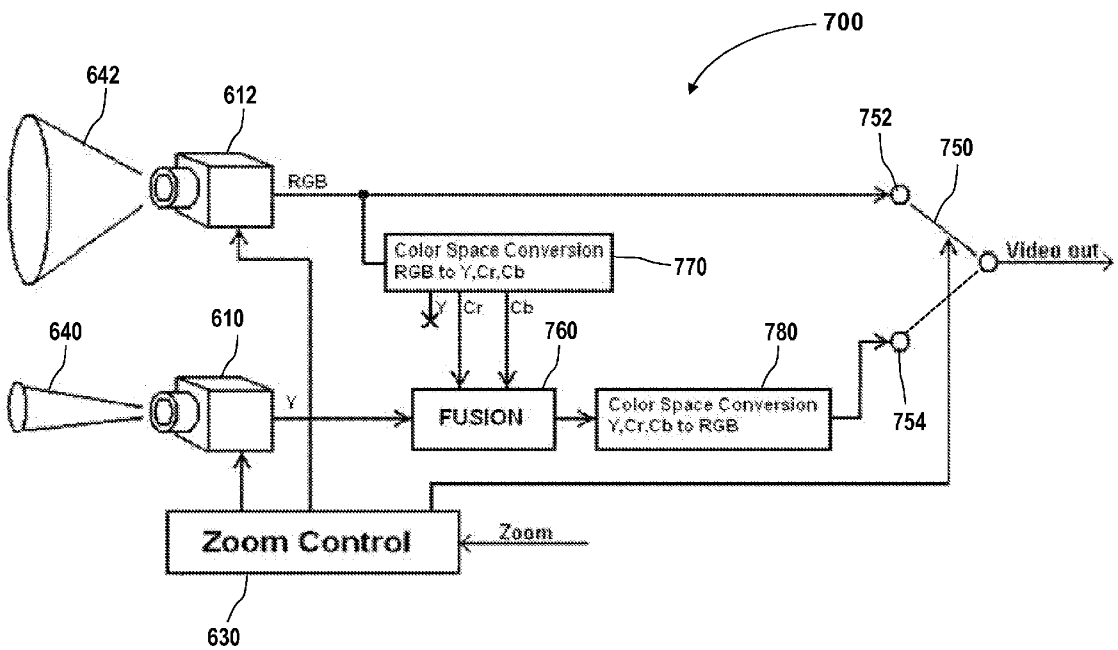
Publication Classification

(51) **Int. Cl.**
H04N 5/262 (2006.01)

(52) **U.S. Cl.** **348/240.2**; 348/E05.055

(57) **ABSTRACT**

A method for continuous electronic zoom in a computerized image acquisition system, the system having a wide image acquisition device and a tele image acquisition device having a tele image sensor array coupled with a tele lens having a narrow FOV, and a tele electronic zoom. The method includes providing a user of the image acquisition device with a zoom selecting control, thereby obtaining a requested zoom, selecting one of the image acquisition devices based on the requested zoom and acquiring an image frame, thereby obtaining an acquired image frame, and performing digitally zoom on the acquired image frame, thereby obtaining an acquired image frame with the requested zoom. The alignment between the wide image sensor array and the tele image sensor array is computed, to facilitate continuous electronic zoom with uninterrupted imaging, when switching back and forth between the wide image sensor array and the tele image sensor array.



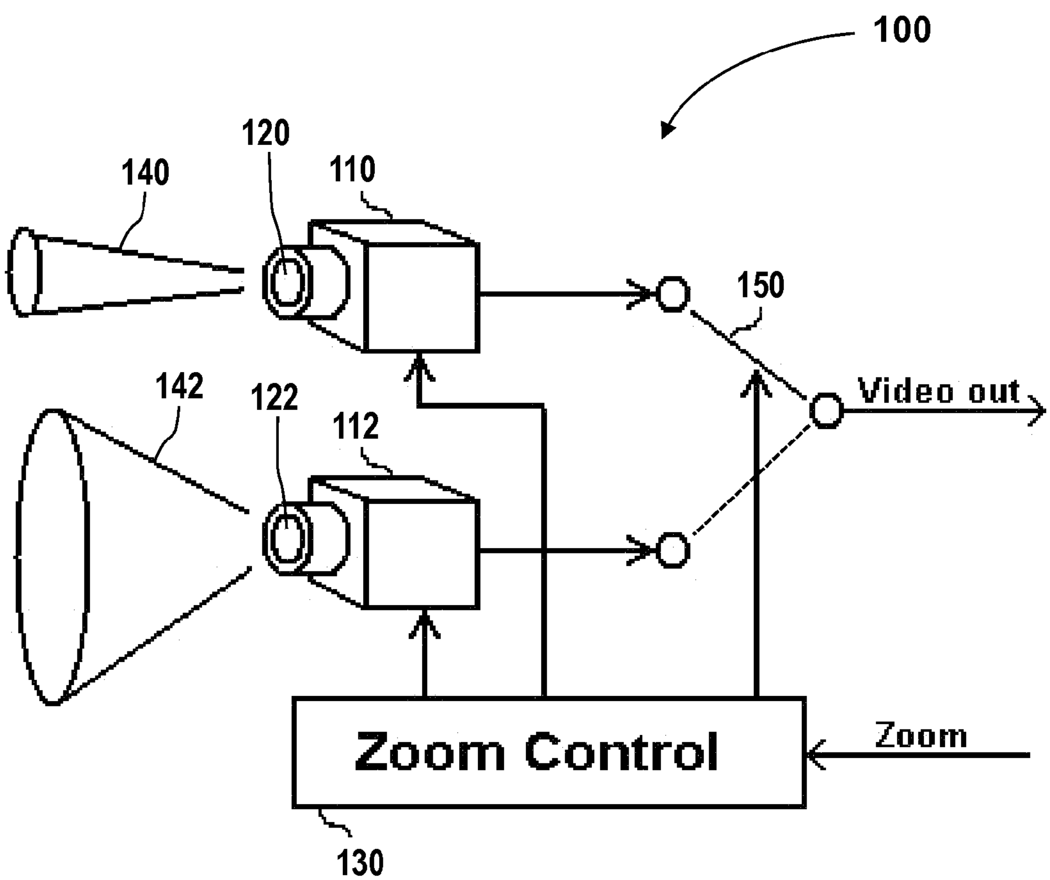

100
120
140
110
150
142
122
112
Video out
Zoom Control
Zoom
130

Fig 1

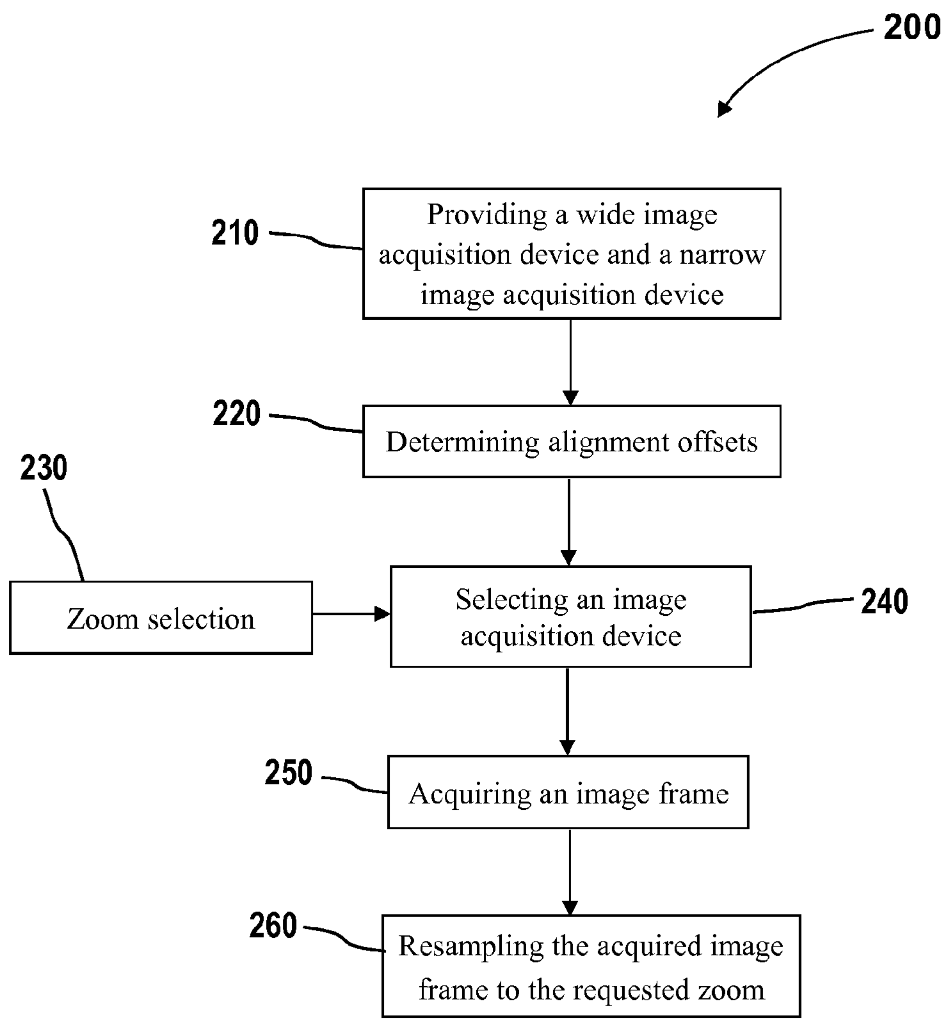

200
210
Providing a wide image acquisition device and a narrow image acquisition device
220
Determining alignment offsets
230
Zoom selection
Selecting an image acquisition device
240
250
Acquiring an image frame
260
Resampling the acquired image frame to the requested zoom

Fig 2

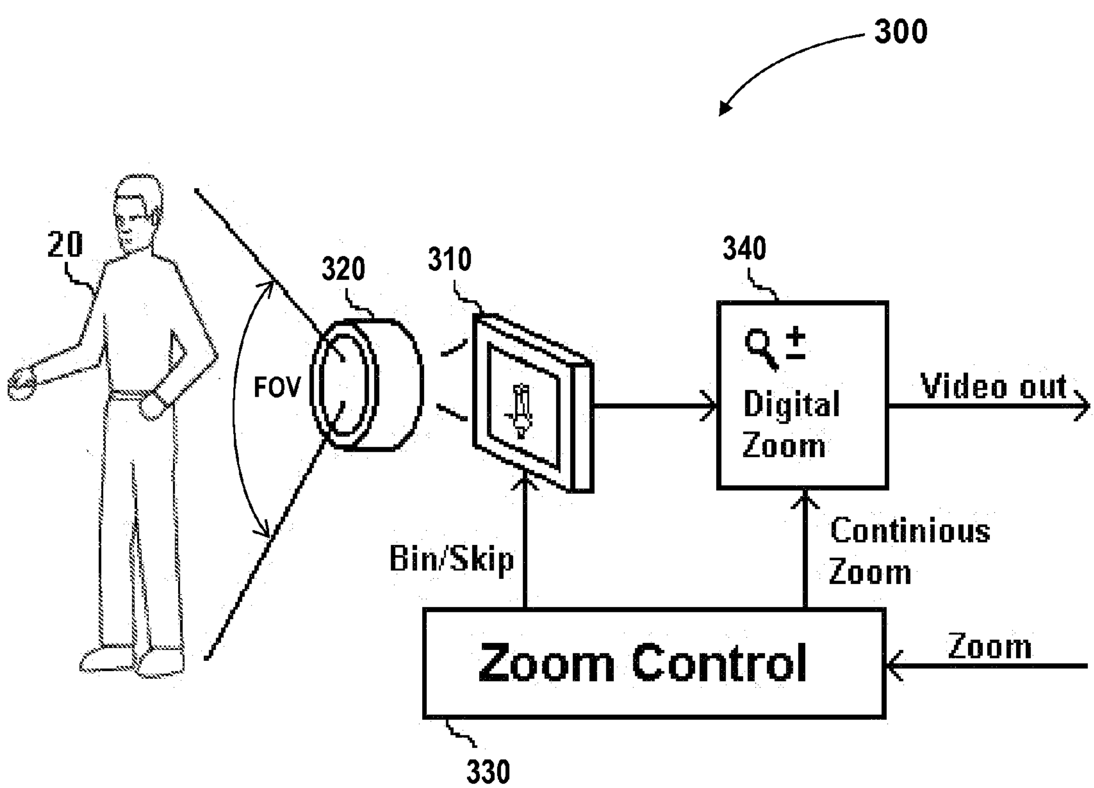

300
20
320
310
340
FOV
Digital
Zoom
Video out
Continious
Zoom
Bin/Skip
Zoom Control
Zoom
330

Fig 3

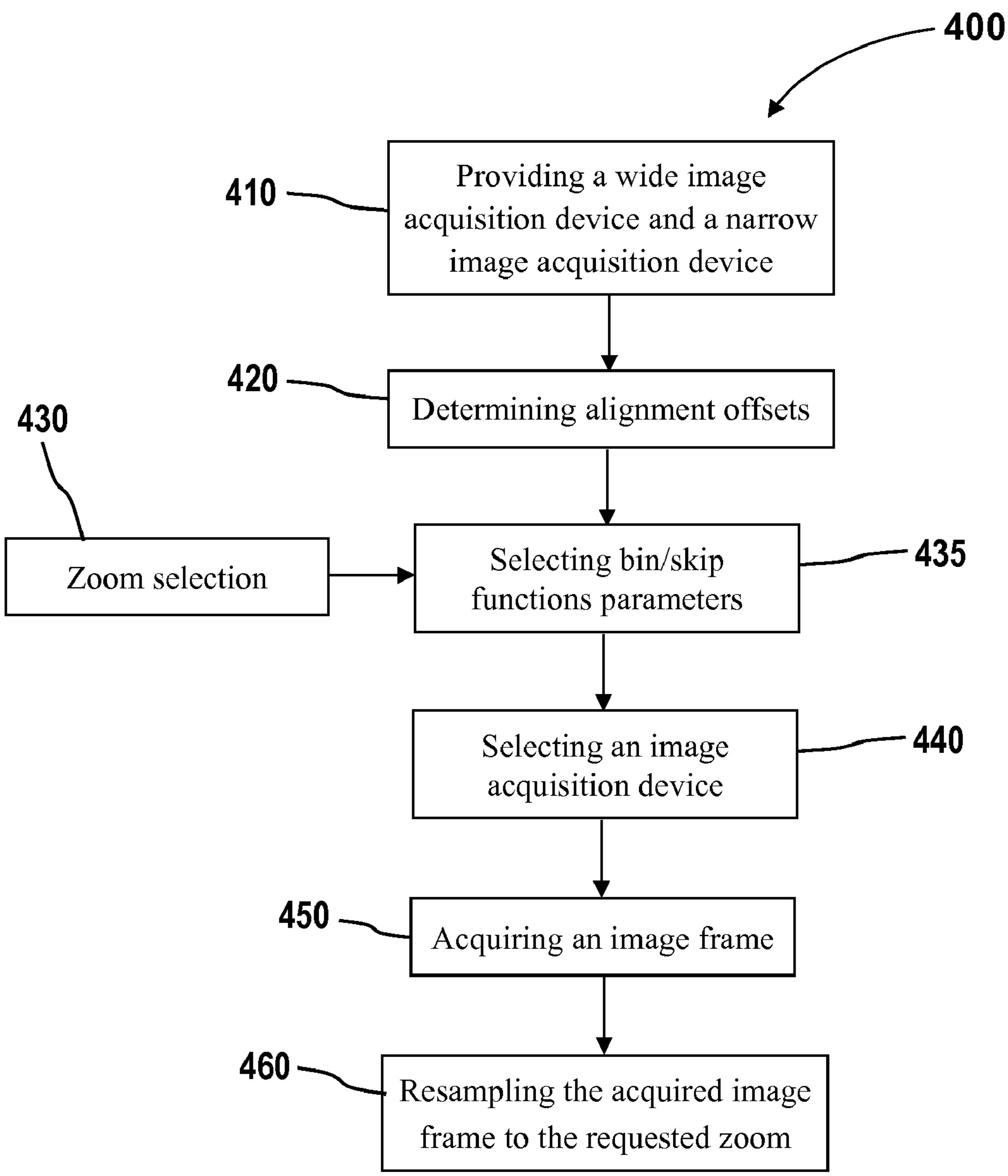

400
410
Providing a wide image acquisition device and a narrow image acquisition device
420
Determining alignment offsets
430
Zoom selection
Selecting bin/skip functions parameters
435
Selecting an image acquisition device
440
450
Acquiring an image frame
460
Resampling the acquired image frame to the requested zoom

Fig 4

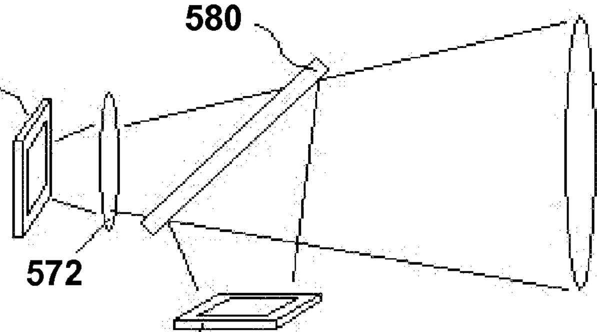


Fig 5a

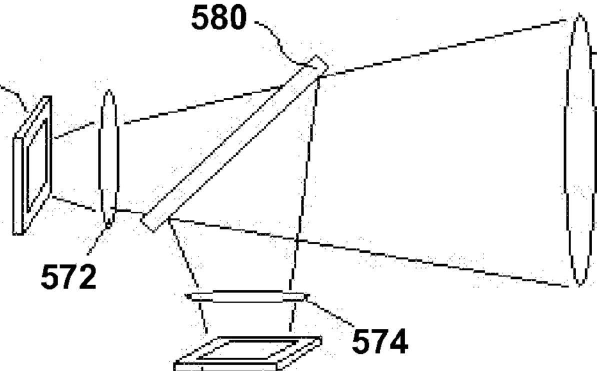


Fig 5b

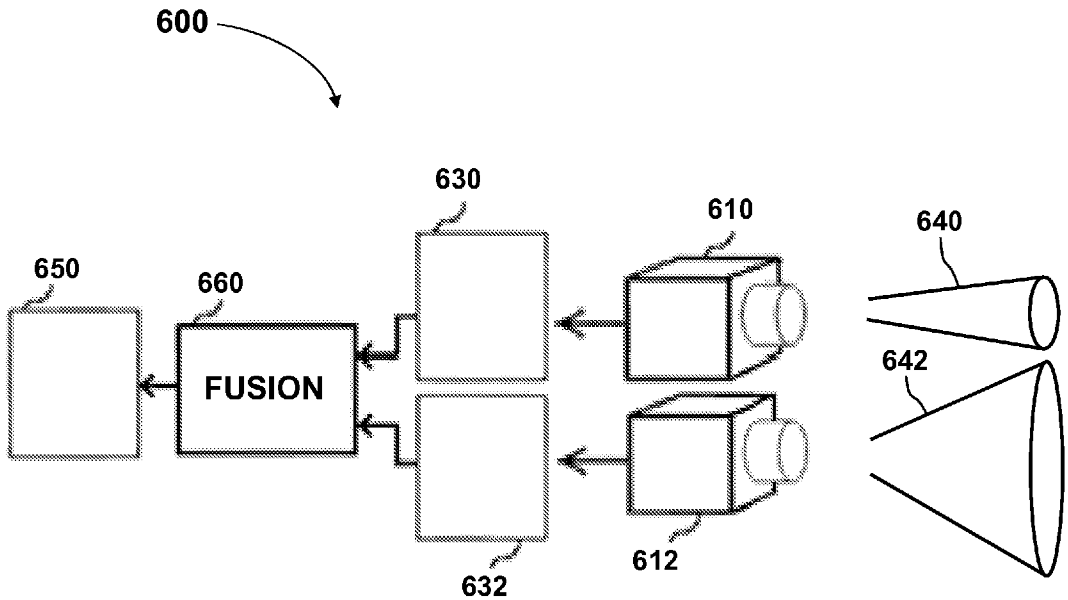


Fig 6

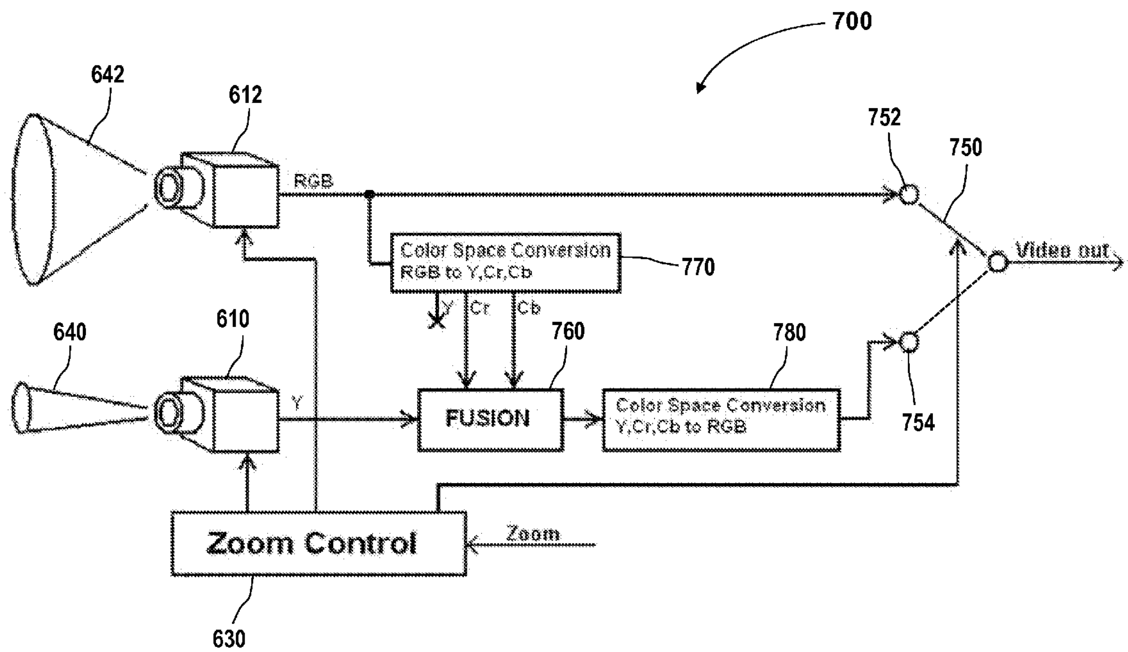

700
642
612
RGB
752
750
Color Space Conversion
RGB to Y,Cr,Cb
770
Video out
Y
Cr
Cb
640
610
760
780
754
Y
FUSION
Color Space Conversion
Y,Cr,Cb to RGB
Zoom Control
Zoom
630

Fig 7

CONTINUOUS ELECTRONIC ZOOM FOR AN IMAGING SYSTEM WITH MULTIPLE IMAGING DEVICES HAVING DIFFERENT FIXED FOV

RELATED APPLICATION

[0001] The present application claims the benefit of U.S. provisional application 61/167,226 filed on Apr. 7, 2009, the disclosure of which is incorporated herein by reference.

FIELD OF THE INVENTION

[0002] The present invention relates to an electronic zoom for imaging systems, and more particularly, the present invention relates to a continuous electronic zoom for an image acquisition system, the system including multiple imaging devices having different fixed FOV.

BACKGROUND OF THE INVENTION AND PRIOR ART

[0003] Digital zoom is a method of narrowing the apparent angle of view of a digital still or video image. Electronic zoom is accomplished by cropping an image down to a centered area of the image with the same aspect ratio as the original, and usually also interpolating the result back up to the pixel dimensions of the original. It is accomplished electronically, without any adjustment of the camera's optics, and no optical resolution is gained in the process. Typically some information is lost in the process.

[0004] In video streams (such as PAL, NTSC, SECAM, 656, etc.) the image resolution is known, and by using image sensors having substantially higher resolution, one can perform lossless electronic zoom. The ratio between the image sensor resolution and the output resolution dictates the lossless electronic zoom range. For example, having a 5 Megapixel, 2592×1944, image sensor array and an output resolution frame of 400×300 yields maximal lossless electronic zoom of 6.48:

[0005] 2592/400=6.48,

[0006] 1944/300=6.48.

[0007] Typically, a camera with a large dynamic zoom range requires heavy and expensive lenses, as well as complex design. Electronic zoom does not need moving mechanical elements, as does optical zoom.

[0008] There is a need for and it would be advantageous to have image sensors, having static, light weight electronic zoom and a large lossless zooming range.

SUMMARY OF THE INVENTION

[0009] The present invention describes a continuous electronic zoom for an image acquisition system, having multiple imaging devices each with a different fixed field of view (FOV). Using two (or more) image sensors, having different fixed FOV, facilitates a light weight electronic zoom with a large lossless zooming range. For example, a first image sensor has a 60° angle of view and a second image sensor has a 60° angle of view. Therefore, Wide_FOV=Narrow_FOV*6. Hence, switching between the image sensors provide a lossless electronic zoom of 6^2=36. This lossless electronic zoom is also referred to herein, as the optimal zoom:

$$\text{Optimal\_Zoom}=(\text{Wide\_FOV}/\text{Narrow\_FOV})^2.$$

[0010] It should be noted that to obtain similar zoom (×36) by optical means, for an output resolution frame of 400×300, the needed image sensor array is:

[0011] 36*400=14400,

[0012] 36*300=10800.

[0013] 14400*10800=155,520,000.

Hence, to obtain a zoom of ×36 by optical means, for an output resolution frame of 400×300, one needs a 155 Megapixel, 14400×10800, image sensor array.

[0014] According to teachings of the present invention, there is provided a method for continuous electronic zoom in a computerized image acquisition system, the system having multiple optical image acquisition devices each with a FOV. The method includes providing a first image acquisition device having a first image sensor array coupled with a first lens having a first FOV, typically a wide FOV , and a first electronic zoom. The method further includes providing a second image acquisition device having a second image sensor array coupled with a second lens having a second FOV, typically a narrow FOV, and a second electronic zoom. Typically, the angle of view of the first FOV is wider than the angle of view of the second FOV. At least a portion of the environment, viewed from within the second FOV of the second image acquisition device, overlaps the environment viewed from within the first FOV of the first image acquisition device. The method further includes computing the alignment between the first image sensor array and the second image sensor array, whereby determining an X-coordinate offset, a Y-coordinate offset and optionally, a Z-rotation offset of the correlation between the first image sensor array and the second image sensor array.

[0015] The method further includes the steps of providing a user of the image acquisition device with a zoom selecting control, thereby obtaining a requested zoom, selecting one of the image acquisition devices based on the requested zoom, acquiring an image frame with the selected image acquisition device, thereby obtaining an acquired image frame, and performing digitally zoom on the acquired image frame, thereby obtaining an acquired image frame with the requested zoom. The calibration of the alignment, between the first image sensor array and the second image sensor array, facilitates continuous electronic zoom with uninterrupted imaging, when switching back and forth between the first image sensor array and the second image sensor array. Preferably the electronic calibration is performed with sub-pixel accuracy.

[0016] Optionally, the computerized image acquisition system is configured to provide zooming functions selected from the group consisting of a bin function and a skip function. The selecting of the image acquisition device includes selecting the parameters of the bin and/or skip functions, wherein the method further includes the step of applying the selected bin/skip functions to the acquired image frame, before the performing of the digital zoom step.

[0017] In variations of the present invention, the image sensor arrays are focused to the infinite.

[0018] Optionally, the first lens is a focus adjustable lens.

[0019] Optionally, the second lens is a focus adjustable lens.

[0020] Optionally, the second lens is a zoom lens.

[0021] In image acquisition systems having more than two imaging devices, the electronic calibration step is performed on each pair of adjacently disposed image sensor arrays.

[0022] In variations of the present invention, the first image acquisition device and the second image acquisition device

are coupled with a mutual front lens and a beam splitter, wherein one portion of the light reaching the beam splitter is directed towards the first image sensor array and the remainder portion of the light reaching the beam splitter is directed towards the second image sensor array.

[0023] In embodiments of the present invention, the first image sensor array is a color sensor and the second image sensor array is a monochrome sensor, wherein a colored image frame is acquired by the first image sensor array, a monochrome image frame is acquired by the second image sensor array, wherein the colored image frame and the monochrome image frame are fused to form a high resolution colored image frame. In preferred embodiments of the present invention, the angle of view of the first FOV is wider than the angle of view of the second FOV. However, in variation of the present invention, the angle of view of the first FOV is substantially equal to the angle of view of the second FOV.

[0024] Optionally, the fusion of the colored image frame and the monochrome image frame includes the step of computing color values for the high resolution pixels of the monochrome image frame from the respective low resolution pixels of the colored image frame. Optionally, the computing of color values is performed in sub pixel accuracy.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025] The present invention will become fully understood from the detailed description given herein below and the accompanying drawings, which are given by way of illustration and example only and thus not limitative of the present invention, and wherein:

[0026] FIG. **1** is a block diagram illustration of another zoom control sub-system for an image acquisition system, according to variations of the present invention;

[0027] FIG. **2** is a schematic flow diagram chart that outlines the successive steps of the continuous zoom process, according to embodiments of the present invention;

[0028] FIG. **3** is a block diagram illustration of a zoom control sub-system for an image acquisition system, according to variations of the present invention;

[0029] FIG. **4** is a schematic flow diagram chart that outlines the successive steps of the continuous zoom process, according to variations of the present invention, include using bin/skip functions;

[0030] FIGS. **5***a* and **5***b* illustrate examples of beam splitter configurations for image acquisition systems, according to embodiments of the present invention;

[0031] FIG. **6** is a block diagram illustration of a camera system, according to embodiments of the present invention, including a color image sensor having wide FOV and a color image sensor having narrow FOV; and

[0032] FIG. **7** is a block diagram illustration of another zoom control sub-system for a color image acquisition system, according to variations of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0033] Before explaining embodiments of the invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangement of the components set forth in the host description or illustrated in the drawings.

[0034] Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art of the invention belongs. The methods and examples provided herein are illustrative only and not intended to be limiting.

[0035] It should be noted that in general, the present invention is described, with no limitations, in terms of an image acquisition system having two image acquisition devices. But the present invention is not limited to two image acquisition devices, and in variations of the present invention, the image acquisition system can be similarly embodied with three image acquisition devices and more.

[0036] Reference is made to FIG. **1**, which is a block diagram illustration of a zoom control sub-system **100** for an image acquisition system, according to preferred embodiments of the present invention. Zoom control sub-system **100** includes multiple image sensors, each with a fixed and preferably different FOV, configured to provide continuous electronic zoom capabilities with uninterrupted, when switching back and forth between the image sensors.

[0037] Zoom control sub-system **100** includes a tele image sensor **110** coupled with a narrow lens **120** having a predesigned FOV **140**, a wide image sensor **112** coupled with a wide lens **122** having a predesigned FOV **142**, a zoom control module **130** and an image sensor selector **150**. An object **20** is viewed from both tele image sensor **110** and wide image sensor **112**, whereas the object is magnified in tele image sensor **110** with respect to wide image sensor **112**, by a predesigned factor. In the optimal configuration, the FOV of wide image sensor **112** can be calculated by multiplying the FOV of tele image sensor **110** by the optimal zoom of image sensors **110** and **112**. Tele image sensor **110** and wide image sensor **112** are adjacently disposed, such that at least a portion of the environment viewed from within the narrow FOV of tele image acquisition device **110** overlaps the environment viewed from within the wide FOV of wide image acquisition device **112**.

[0038] Before using zoom control sub-system **100**, an electronically calibrating is performed to determine the alignment offsets between wide image sensor array **110** and tele image sensor array **112**. Typically, since the spatial offsets between wide image sensor array **110** and tele image sensor array **112** are fixed, the electronic calibration step is performed one time, after the manufacturing of the image acquisition system and before the first use. The electronic calibration yields an X-coordinate offset, a Y-coordinate offset and optionally, a Z-coordinate rotational offset of the correlation between wide image sensor array **110** and tele image sensor array **112**. Preferably, all three aforementioned offset values are computed in sub-pixel accuracy. It should be noted that for image acquisition systems with more than two image sensors, the electronic calibration step is performed on each pair of adjacently disposed image sensor arrays.

[0039] Zoom control circuit **130** receives a required zoom from an operator of the image acquisition system, and selects the relevant image sensor (**110** and **112**) by activating image sensor selector **150** position. The relevant camera zoom factor is calculated by zoom control unit **130**.

[0040] An aspect of the present invention is to provide methods facilitating continuous electronic zoom capabilities with uninterrupted imaging, performed by an image acquisition system having multiple image sensors, each with a fixed and preferably different FOV. The continuous electronic zoom with uninterrupted imaging is also maintained when switching back and forth between adjacently disposed image sensors.

[0041] Reference is also made to FIG. **2**, which is a schematic flow diagram chart that outlines the successive steps of an example continuous zoom process **200**, according to embodiments of the present invention, performed on image acquisition system, having a zoom control sub-system such as zoom control sub-system **100**. Process **200** includes the flowing steps:

Step **210**: providing a wide image acquisition device and a tele image acquisition device.

[0042] Multiple optical image acquisition devices can be used, but for description clarity, with no limitation, the method will be described in terms of two image acquisition devices: wide image acquisition device and a tele image acquisition device.

[0043] Both image acquisition devices (**110** and **112**) include an image sensor array coupled with a lens (**120** and **122**, respectively), providing a fixed FOV (tele FOV **140** and wide FOV **142**, respectively). Preferably, wide FOV **142** is substantially wider than narrow FOV **140**.

[0044] The image acquisition devices are adjacently disposed, such that at least a portion of the environment, viewed from within narrow FOV **140** of the tele image acquisition device **110**, overlaps the environment viewed from within the wide FOV **142** of wide image acquisition device **112**.

Step **220**: determining alignment offsets.

[0045] Before using zoom control sub-system **100**, an electronically calibrating is performed to determine the alignment offsets between wide image sensor array **110** and tele image sensor array **112**. Typically, since the spatial offsets between wide image sensor array **110** and tele image sensor array **112** are fixed, the electronic calibration step is performed one time, after the manufacturing of the image acquisition system and before the first use. The electronic calibration yields an X-coordinate offset and a Y-coordinate offset of the correlation between wide image sensor array **110** and tele image sensor array **112**. Preferably, the X-coordinate offset and the Y-coordinate offset are computed in sub-pixel accuracy. It should be noted that for image acquisition systems with more than two image sensors, the electronic calibration step is performed on each pair of adjacently disposed image sensor arrays.

Step **230**: zoom selection.

[0046] A user of the image acquisition selects the required zoom.

Step **240**: selecting an image acquisition device.

[0047] The zoom control **130** selects an image acquisition device with the having a zoom more proximal to the requested zoom.

Step **250**: acquiring an image frame.

[0048] An image frame is acquired by the selected image acquisition device.

Step **260**: resampling the acquired image frame to the requested zoom.

[0049] The zoom control **130** computes the zoom factor between the fixed zoom of the selected image acquisition device and the requested zoom. Based on the computed factor, zoom control **130** performs electronic zoom on the acquired image frame to meet the requested zoom.

[0050] Reference is made back to FIG. **1** and referring also to FIGS. **5***a* and **5***b*, which illustrates examples of beam splitter configurations for image acquisition systems, according to embodiments of the present invention. In variations of the present invention, wide image acquisition device **112** and tele image acquisition device **110** are coupled with a mutual front lens **570** and a beam splitter **580**, wherein one portion of the light reaching beam splitter **580** is directed towards wide image sensor array **112** and the remainder portion of the light reaching beam splitter **580** is directed towards tele image sensor array **110**. In FIG. **5***a*, the beam splitter configuration includes a wide angle lens **572**, to provide image sensor **510** a wider FOV with respect to image sensor **512**. In FIG. **5***b*, the beam splitter configuration includes wide angle lens **572**, to provide image sensor **510** a wide FOV, and a narrow angle lens **574**, to provide image sensor **512** a narrow FOV, relative to the FOV of image sensor **512**.

[0051] Reference is now made to FIG. **3**, which is a block diagram illustration of zoom control sub-system **300** for an image acquisition system, according to some embodiments of the present invention. Zoom control sub-system **300** includes an image sensor **310** having a lens module **320** with a fixed focal length lens or a zoom lens, a zoom control module **330** and a digital-zoom module **340**. An object **20** is captured by image sensor **310** through lens module **320**. Zoom control unit **330** calculates the most optimal values for image sensor **310**, binning/skip factors and continuous digital-zoom values that are provided to digital-zoom unit **340**. Setting the binning/skip factor and windowing of image sensor **310** allows to keep a suitable frame refresh rate, while digital-zoom unit **340** provides continuous zoom.

[0052] A binning function, which function is optionally provided by the sensor array provider, is a zoom out function that merges 2×2, or 4×4, or 8×8 pixels pixel array, or any other square array of pixels, into a single pixel, whereby reducing the image frame dimensions. The binning function may be refined by using algorithms such as "bi-linear" interpolation, "bi-cubic" interpolation and other commonly used digital zoom algorithms. A skip function, which function is optionally provided by the sensor array provider, is a zoom out function that allows skipping pixels while reading frame out, whereby reducing the image frame dimensions and decrease the image acquisition time.

[0053] In variations of the present invention, zoom control sub-system **100** of a image acquisition system includes the binning/skip function capabilities as in zoom control subsystem **300**.

[0054] Reference is also made to FIG. **4**, which is a schematic flow diagram chart that outlines the successive steps of an example continuous zoom process **400**, according to embodiments of the present invention, performed on image acquisition system, having a zoom control sub-system such as zoom control sub-system **100**. Process **400** includes the flowing steps:

Step **410**: providing a wide image acquisition device and a tele image acquisition device.

[0055] Multiple optical image acquisition devices can be used, but for description clarity, with no limitation, the method will be described in terms of two image acquisition devices: wide image acquisition device and a tele image acquisition device.

[0056] Both image acquisition devices (**110** and **112**) include an image sensor array coupled with a lens (**120** and **122**, respectively), providing a fixed FOV (tele FOV **140** and wide FOV **142**, respectively). Preferably, wide FOV **142** is substantially wider than narrow FOV **140**.

[0057] The image acquisition devices are adjacently disposed, such that at least a portion of the environment, viewed from within narrow FOV **140** of the tele image acquisition device **110**, overlaps the environment viewed from within the wide FOV **142** of wide image acquisition device **112**.

Step **420**: determining alignment offsets.

[0058] Before using zoom control sub-system **100**, an electronically calibrating is performed to determine the alignment offsets between wide image sensor array **110** and tele image sensor array **112**. Typically, since the spatial offsets between wide image sensor array **110** and tele image sensor array **112** are fixed, the electronic calibration step is performed one time, after the manufacturing of the image acquisition system and before the first use. The electronic calibration yields an X-coordinate offset, a Y-coordinate offset and optionally, a Z-coordinate rotational offset of the correlation between wide image sensor array **110** and tele image sensor array **112**. Preferably, all three aforementioned coordinate offset values are computed in sub-pixel accuracy. It should be noted that for image acquisition systems with more than two image sensors, the electronic calibration step is performed on each pair of adjacently disposed image sensor arrays.

Step **430**: zoom selection.

[0059] A user of the image acquisition selects the required zoom.

Step **435**: bin/skip function selection.

[0060] The zoom control **130** selects the bin/skip function, typically provided by the image sensor provider, bringing the combination of the optical zoom and the binning/skip magnification selection, to a zoom value most proximal to the requested zoom.

Step **440**: selecting an image acquisition device.

[0061] The zoom control **130** selects an image acquisition device, bringing the combination of the optical zoom and the binning/skip magnification selection, to a zoom value most proximal to the requested zoom.

Step **450**: acquiring an image frame.

[0062] An image frame is acquired by the selected image acquisition device.

Step **460**: performing electronic zoom on the acquired image frame to meet the requested zoom.

[0063] The zoom control **130** computes the zoom factor between the fixed zoom of the selected image acquisition device, combined with the selected by bin/skip factor, and the requested zoom. Based on the computed factor, zoom control **130** performs electronic zoom on the acquired image frame to meet the requested zoom.

[0064] Reference is now made to FIG. **6**, which is a block diagram illustration of a camera system **600**, according to embodiments of the present invention, including a color image sensor **612** having wide FOV **642** and a monochrome image sensor **610** having narrow FOV **640**. The angle of view of wide FOV **142** is typically wider than the angle of view of narrow FOV **140**. In some variations of the present invention, the angle of view of wide FOV **142** is substantially equal to the angle of view of narrow FOV **140**.

[0065] A principal intention of the present invention includes providing a camera system **600** and a method of use thereof, wherein the output image frame **650** has the resolution of image sensor **610**, having narrow FOV **640**, and the color of image sensor **612**, having wide FOV **642**.

[0066] Reference is now made to FIG. **7**, which is a block diagram illustration of another zoom control sub-system **700** for a color image acquisition system, according to variations of the present invention. A colored image frame **632** is acquired by wide image sensor array **612**, and a monochrome image frame **630** is acquired by narrow image sensor array **610**. When image sensor selector **750** closes contact **752**, monochrome image sensor **610** is bypassed and only color image sensor **612** having is in operation.

[0067] When image sensor selector **750** closes contact **754**, both monochrome image sensor **610** and color image sensor **612** are in operation, whereas image frames are acquired by monochrome image sensor **610** and color of image sensor **612**, synchronously. Fusion module **660** extracts the color information from color image frame **632** and fuses the extracted color information with monochrome image frame **630** to form a high resolution, colored image frame **650**. The fusion includes computing color values for the high resolution pixels of monochrome image frame **630** from the respective low resolution color image frame **632**. Preferably, the computation and alignment of the color values is performed in sub pixel accuracy.

[0068] In some variations of the present invention, the output colored image frame **650** is provided with RGB information. In other variations of the present invention, fusion module **760** transmits the Y information, obtained from monochrome image sensor **610** covered with color (Cr, Cb) information obtained from color image sensor **612**. The color information obtained from color image sensor **612** via a color space. Then, fusion module **760** merges the Y information, obtained from monochrome image sensor **610**, and the color (Cr, Cb) information. Then, color space conversion module **770** converts the image back to an RGB color space, creating colored output image frame **650**. Optionally, the (Y, Cr, Cb) image information is transmitted in separate channels to an image receiving unit, bypassing color space conversion module **770**.

[0069] The invention being thus described in terms of embodiments and examples, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the claims.

1. In a computerized image acquisition system, having multiple optical image acquisition devices each with a fixed field of view (FOV), a method for continuous electronic zoom comprising the steps of:

a) providing a first image acquisition device including:
   i) a first image sensor array coupled with a first lens having a first FOV; and
   ii) a first electronic zoom;
b) providing a second image acquisition device including:
   i) a second image sensor array coupled with a second lens having a second FOV; and
   ii) a second electronic zoom;

wherein at least a portion of the environment, viewed from within said second FOV of said second image acquisition device, overlaps the environment viewed from within said first FOV of said first image acquisition device;

c) electronically calibrating the alignment between said first image sensor array and said second image sensor array, whereby determining an X-coordinate offset and a

Y-coordinate offset of the correlation between said first image sensor array and said second image sensor array;

d) providing a user of the image acquisition device with a zoom selecting control, thereby obtaining a requested zoom;

e) selecting one of said image acquisition devices based on said requested zoom;

f) acquiring an image frame with said selected image acquisition device, thereby obtaining an acquired image frame; and

g) performing digitally zoom on said acquired image frame, thereby obtaining an acquired image frame with said requested zoom,

wherein said calibrating of said alignment between said first image sensor array and said second image sensor array, facilitates continuous electronic zoom with uninterrupted imaging, when switching back and forth between said first image sensor array and said second image sensor array.

2. The method as in claim **1**, wherein the computerized image acquisition system is configured to provide zooming functions selected from the group consisting of a bin function and a skip function; wherein said selecting of said image acquisition device includes selecting the parameters of said bin and/or skip functions; and wherein said method further includes the step of applying said selected bin/skip functions, with said selected parameters, to said acquired image frame, before said performing of said digital zoom step.

3. The method as in claim **1**, wherein said image sensor arrays are focused to the infinite.

4. The method as in claim **1**, wherein a lens, selected from the group consisting of said first lens and said second lens, is a focus adjustable lens.

5. The method as in claim **1**, wherein a lens, selected from the group consisting of said first lens and said second lens, is a focus adjustable lens.

6. The method as in claim **1** wherein said second lens is a zoom lens.

7. The method as in claim **1**, where said electronic calibration of said alignment between said first image sensor array and said second image sensor array, further determines a Z-coordinate rotational offset of the correlation between said first image sensor array and said second image sensor array.

8. The method as in claim **1**, wherein said electronic calibration is performed with sub-pixel accuracy.

9. The method as in claim **1**, wherein said electronic calibration step is performed on each pair of adjacently disposed image sensor arrays.

10. The method as in claim **1**, wherein said first image acquisition device and said second image acquisition device are coupled with a mutual front lens and a beam splitter, wherein one portion of the light reaching said beam splitter is directed towards said first image sensor array and the remainder portion of the light reaching said beam splitter is directed towards said second image sensor array.

11. The method as in claim **1**, wherein the angle of view of said first FOV is wider than the angle of view of said second FOV.

12. The method as in claim **1**, wherein said first image sensor array is a color sensor and said second image sensor array is a monochrome sensor,

wherein a colored image frame is acquired by said first image sensor array;

wherein a monochrome image frame is acquired by said second image sensor array; and

wherein said colored image frame and said monochrome image frame are fused to form a high resolution colored image frame.

13. The method as in claim **12**, wherein said fusion of said colored image frame and said monochrome image frame includes the step of computing color values for the pixels of said monochrome image frame from the respective pixels of said colored image frame.

14. The method as in claim **12**, wherein the angle of view of said first FOV is wider than the angle of view of said second FOV.

15. The method as in claim **12**, wherein the angle of view of said first FOV is substantially equal to the angle of view of said second FOV.

16. The method as in claim **13**, wherein said computing of color values is performed in sub pixel accuracy.

17. The method as in claim **2**, wherein said image sensor arrays are focused to the infinite.

18. The method as in claim **2**, wherein said second lens is a zoom lens.

19. The method as in claim **7**, wherein said electronic calibration is performed with sub-pixel accuracy.

* * * * *

(19) Japan Patent Office (JP)
(12) Unexamined Patent Application Publication (A)
(11) Patent Application Publication No. S58-62609

(51) Int. Cl.[3]		Ident. Code	Internal Ref. No.
G 02 B	13/02		7529-2H
// G 02 B	9/34		6952-2H

(43) Pub. Date: Apr. 14, Showa 58 (1983)
No. of Inventions: 1
Examination Request: Not Made
(5 Pages Total)

(54) Telephoto Lens

(21) Filing No. S56-160716
(22) Filing Date Oct. 8, Showa 56 (1981)
(72) Inventor Noriaki Kawamura
c/o Asahi Optical Co. Ltd.
2-36-9 Maeno-chō, Itabashi-ku, Tokyo
(71) Applicant Asahi Optical Co. Ltd.
2-36-9 Maeno-chō, Itabashi-ku, Tokyo

Specification

1. Title Telephoto Lens
2. Scope of Patent Claim

A telephoto lens of a four-group, five-lens configuration of, in order from an object side, a first lens, which is a positive meniscus lens that is convex toward the object side; a second lens and a third lens, which are a laminated positive meniscus lens of a negative meniscus lens and positive meniscus lens having a lamination surface that is convex toward the object side; a fourth lens, which is a negative lens having a rear surface with a large curvature that is concave toward an image-surface side; and a fifth lens, which is a positive lens, wherein the telephoto lens has a favorable aberration situation that satisfies all of the following conditions (1) to (8):

(1) $0.3F < F_{1 \cdot 2 \cdot 3} < 0.5F$

(2) $1.0F < F_{1 \cdot 2 \cdot 3 \cdot 4} < 2.5F$

(3) $0.1F < d_1 + d_2 + d_3 + d_4 + d_5 + d_6 < 0.2F$

(4) $0.1F < d_7 < 0.3F$

(5) $30 < \nu_4 < 50$

(6) $0.1F < r_4 < 0.25F$

(7) $0.05 < n_2 - n_3 < 0.3$

(8) $5 < \nu_3 - \nu_2 < 50$

F being a focal length of an overall system, $F_{1, 2 \dots i}$ being a composite focal length to an ith lens, n_i being a refractive index of a d-line of the ith lens, ν_i being an Abbe number of the ith lens, r_j being a jth curvature radius, and d_j being a jth surface interval.

3. Detailed Description of Invention

The present invention relates to a medium telephoto lens of a brightness of about 1:4 and is applied as, for example, a lens of a focal length of about 200 mm for a screen size of 6×7 or a focal length of about 150 mm for a screen size of 4.5×6. A lens type is a so-called Ernostar type, and conventionally, this type tends to overcorrect spherical aberration of color—in particular, spherical aberration of a peripheral luminous flux of short-wavelength light near a g-line—even when other aberration is corrected favorably. Moreover, chromatic aberration in magnification is also comparatively large.

An object of the present invention is to provide a lens that keeps a compactness of an overall length to a conventional level of a telephoto ratio of about 0.96 to 0.88 but has an excellent image-formation performance due to favorably correcting spherical aberration of both a reference wavelength and color and also decreasing chromatic aberration in magnification.

First, a lens configuration of the present invention is described. The present invention is a telephoto lens of a four-group, five-lens configuration of a first lens, which is a positive meniscus lens that is convex toward an object side; a

second lens and a third lens, which are a laminated positive meniscus lens of a negative meniscus lens and positive meniscus lens having a lamination surface that is convex toward the object side; a fourth lens, which is a negative lens having a rear surface with a large curvature that is concave toward an image-surface side; and a fifth lens, which is a positive lens, wherein the telephoto lens satisfies all of the following conditions:

(1) $0.3F < F_{1 \cdot 2 \cdot 3} < 0.5F$

(2) $1.0F < F_{1 \cdot 2 \cdot 3 \cdot 4} < 2.5F$

(3) $0.1F < d_1 + d_2 + d_3 + d_4 + d_5 + d_6 < 0.2F$

(4) $0.1F < d_7 < 0.3F$

(5) $30 < \nu_4 < 50$

(6) $0.1F < r_4 < 0.25F$

(7) $0.05 < n_2 - n_3 < 0.3$

(8) $5 < \nu_3 - \nu_2 < 50$

The reference signs are defined as follows:
F: Focal length of overall system
$F_{1, 2 \ldots i}$: Composite focal length to ith lens
n_i: Refractive index of d-line of ith lens
v_i: Abbe number of ith lens
r_j: jth curvature radius
d_j: jth surface interval
ω: Half angle of view

Each of the above conditions is described below.

Condition (1) is a condition that, in connection with conditions (2) and (3), indicates an allocation of a focal length necessary to set a telephoto ratio to about 0.96 to 0.88 and form a framework of the telephoto lens that favorably corrects aberration. If the upper limit is exceeded, a surface interval d_5 between the third lens and the fourth lens must be increased considerably to maintain compactness, making chromatic aberration and other aberration difficult to correct. Moreover, if the lower limit is exceeded, a greater proportion of the power burden falls to the first lens to the third lens thus necessitating the use of a positive lens with a large refractive index as the first lens and the third lens. This also creates difficulties in terms of a Petzval sum, glass formulation, and the like and causes reduced performance.

Condition (2) is a condition that establishes a power of the fourth lens under condition (1). If $F_{1, 2, 3, 4}$ are longer than the upper limit, telephoto ratios at these points increase. As such, for compactness, the fifth lens must be disposed as close as possible, resulting in unbalanced correction of chromatic aberration and loss of aberration balance. Moreover, if these are shorter than the lower limit, a power of the fifth lens becomes too small such that all aberration arising in the first to fourth lenses cannot be corrected in a balanced manner.

Condition (3) is a condition mainly for maintaining a normal Petzval sum but is also for maintaining the telephoto ratio in the intended range. Exceeding the upper limit is advantageous for the telephoto ratio but disadvantageous for the Petzval sum, and exceeding the lower limit is the inverse of this. As such, in either situation, aberration is unsatisfactory at an intended angle of view.

Condition (4) is a condition relating to a position of the fifth lens. If d_7 is greater than the upper limit, a diameter of the fifth lens is too large to maintain an appropriate peripheral light amount, which is not preferable in terms of frame configuration. Moreover, if d_7 is smaller than the lower limit, coma aberration arises, which is not preferable due to correction thereof being difficult.

Condition (5) relates to the fourth lens. It also relates to conditions (6), (7), and (8) and has great significance in the present invention. Whereas a general Ernostar-type lens performs color correction using one negative lens, the lens of the present invention adds another negative lens (the second lens) to distribute color correction. This has an effect of being able to suppress overcorrection of chromatic aberration in a peripheral luminous flux that conventionally arises in a negative lens and being able to obtain a comparatively large value for v_4 due to the assignment of color correction. This is effective in decreasing chromatic aberration and magnification chromatic aberration in a secondary spectrum. Moreover, in terms of a distribution of glass materials, those with a low refractive index can also be used. This also has an effect on the allotment of other glass materials. If the lower limit is exceeded, as above, correcting chromatic aberration of a peripheral luminous flux is difficult. Moreover, if the upper limit is exceeded, an effect of color correction by the fourth lens becomes small, necessitating a considerable power increase in the fourth lens. This causes considerable difficulties in other aberration correction.

Conditions (6), (7), and (8) are conditions relating to the laminated lens of the second and third lenses. They are mainly conditions for distributing chromatic aberration correction together with the fourth lens and maintaining other aberration to be appropriate. Conditions (6), (7), and (8) fulfill these roles in connection with each other.

Condition (6) establishes a range of a curvature radius of the lamination surface. If the upper limit is exceeded, in terms of aberration correction, the upper limit of condition (7) or condition (8) needs to be exceeded; when selecting

within a scope of commercially available glass materials, this requires the use of a special glass material, which is inappropriate for a lens of a comparatively large diameter. Moreover, if the lower limit is exceeded, the curvature radius of the lamination surface is too small, which increases manufacturing difficulty and makes correction of chromatic aberration of a peripheral luminous flux difficult.

With condition (7), if the upper limit is exceeded, in the range of condition (6), a refractive power of a fourth surface r_4 is too strong. This is inappropriate for the correction of chromatic aberration of a peripheral luminous flux intended by the present invention. Moreover, if the lower limit is exceeded, an effect of the second lens decreases, and to raise the effect of the second lens, the lower limit of condition (6) or the upper limit of condition (8) must be exceeded. This makes it difficult to correct chromatic aberration and other aberration in a balanced manner.

Condition (8) is a condition of achromatization. When this is smaller than the lower limit, an achromatizing distribution of the second lens is too small and inappropriate such that the effects of the present invention are not exhibited. Moreover, when the upper limit is exceeded, chromatic aberration of a peripheral luminous flux arises, which is not preferable.

Next, numerical values of examples of the present invention are listed.

Example 1

1 : 4.1 $F = 200.079$ $\omega = 12.3°$

NO.	r	d	N	ν
1	57.091	9.00	1.60311	60.7
2	330.000	0.20		
3	45.039	4.00	1.67270	32.1
4	33.450	9.60	1.48749	70.1
5	81.000	3.50		
6	387.380	3.00	1.57501	41.5
7	34.361	41.80		
8	146.228	4.34	1.74950	35.3
9	552.040			

$F_{1\cdot2\cdot3} = 74.912$

$F_{1\cdot2\cdot3\cdot4} = 356.466$

$d_1 + d_2 + d_3 + d_4 + d_5 + d_6 = 29.3$

Example 2

1 : 4.1 F = 199.419 $\omega = 12.4°$

NO.	r	d	n	ν
1	56.700	8.50	1.60311	60.7
2	263.618	0.2		
3	45.570	5.6	1.66755	41.9
4	30.259	9.0	1.49700	81.6
5	85.200	3.13		
6	353.617	4.28	1.57501	41.5
7	34.500	38.24		
8	129.576	4.34	1.74950	35.3
9	400.000			

$F_{1 \cdot 2 \cdot 3} = 77.277$

$F_{1 \cdot 2 \cdot 3 \cdot 4} = 367.730$

$d_1 + d_2 + d_3 + d_4 + d_5 + d_6 = 30.71$

Example 3

1 : 4.1 F = 199.692 $\omega = 12.4°$

NO.	r	d	n	ν
1	53.134	8.50	1.58913	61.0
2	216.482	0.20		
3	42.882	4.00	1.80610	40.9
4	27.695	10.00	1.61800	63.4
5	101.862	3.00		
6	215.992	4.81	1.72000	42.0
7	31.982	42.70		
8	103.244	4.34	1.64769	33.8
9	231.664			

$F_{1 \cdot 2 \cdot 3} = 64.069$

$F_{1 \cdot 2 \cdot 3 \cdot 4} = 319.118$

$d_1 + d_2 + d_3 + d_4 + d_5 + d_6 = 30.51$

Example 4

1 : 4.1 $F = 199.767$ $\omega = 12.4^{\circ}$

NO.	r	d	n	ν
1	50.041	8.50	1.60311	60.7
2	218.067	0.20		
3	39.842	3.72	1.69680	55.5
4	25.661	9.50	1.51633	64.1
5	102.728	2.95		
6	275.049	2.79	1.63980	34.5
7	31.011	49.89		
8	107.040	4.34	1.78472	26.6
9	175.118			

$$F_{1\cdot 2\cdot 3} = 63.147$$

$$F_{1\cdot 2\cdot 3\cdot 4} = 286.461$$

$$d_1 + d_2 + d_3 + d_4 + d_5 + d_6 = 27.66$$

4. Brief Description of Drawings

FIGS. 1, 3, 5, and 7 are lens-system configuration views respectively corresponding to examples 1, 2, 3, and 4 of the present invention, and FIGS. 2, 4, 6, and 8 are aberration curve diagrams respectively corresponding to examples 1, 2, 3, and 4.

Applicant: Asahi Optical Co. Ltd.

[Illegible]

Representative: Tōru Matsumoto

FIG. 1

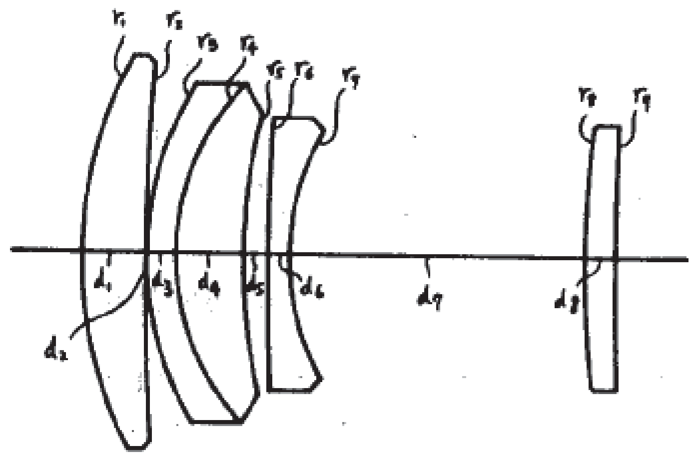
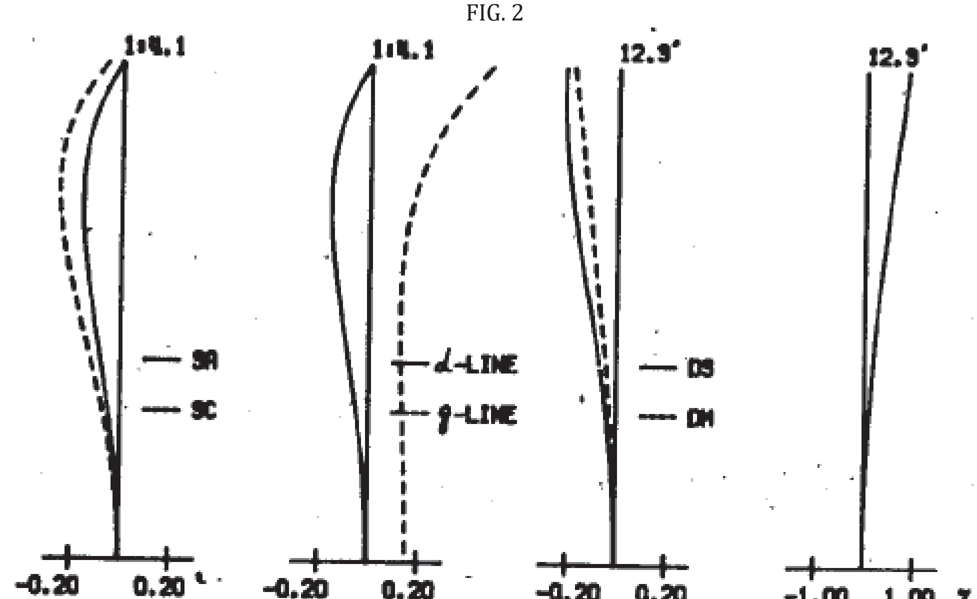


FIG. 2



Spherical aberration Sine conditions

Chromatic aberration

Astigmatism

Distortion aberration

FIG. 3

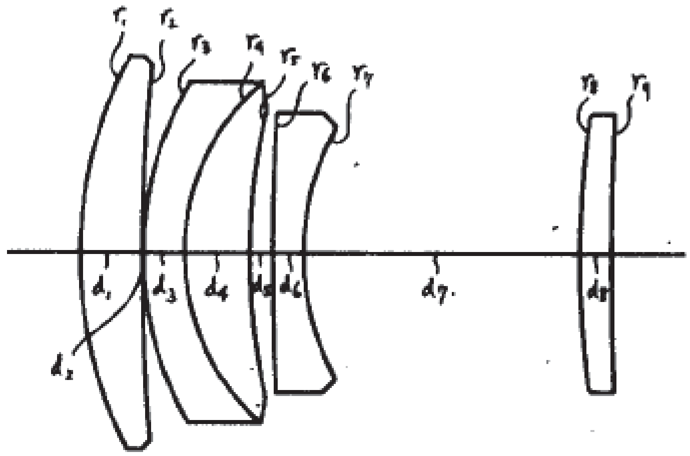
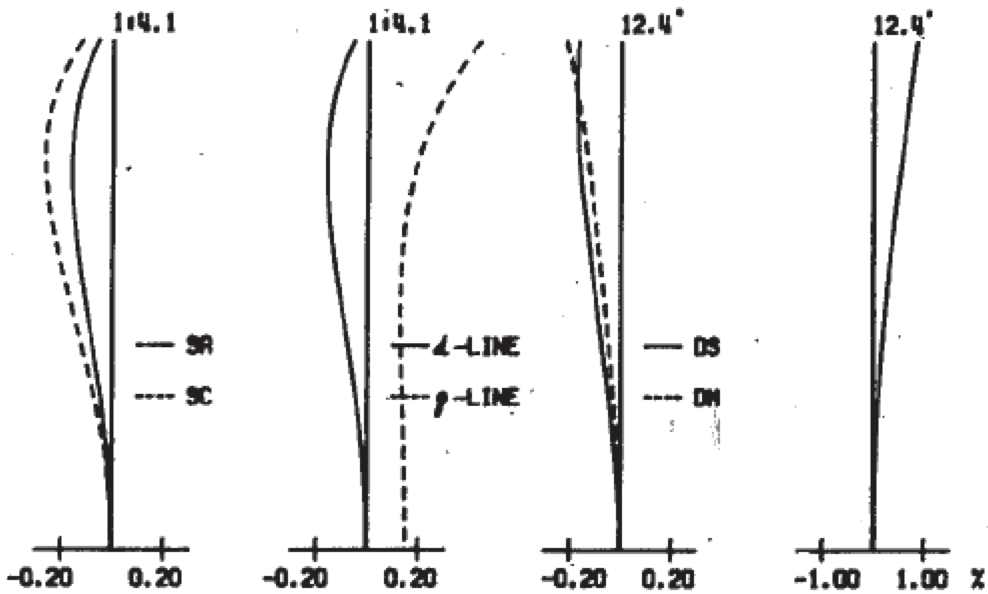


FIG. 4



Spherical aberration
Sine conditions

Chromatic aberration

Astigmatism

Distortion aberration

FIG. 5

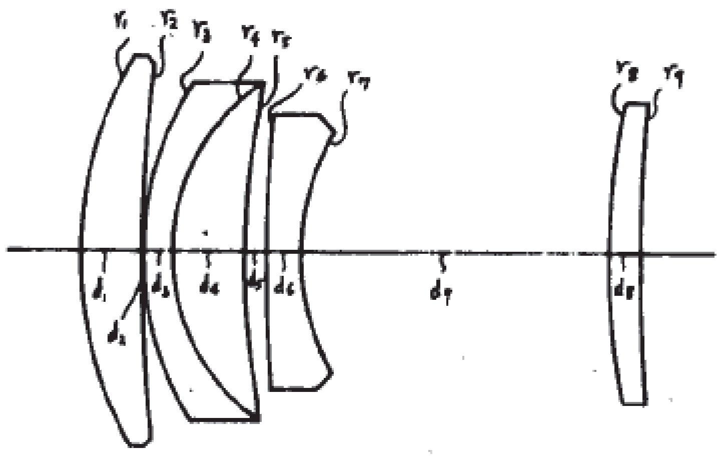

r1
r2
r3
r4
r5
r6
r7
r8
r9
d1
d2
d3
d4
d5
d6
d7
d8

FIG. 6

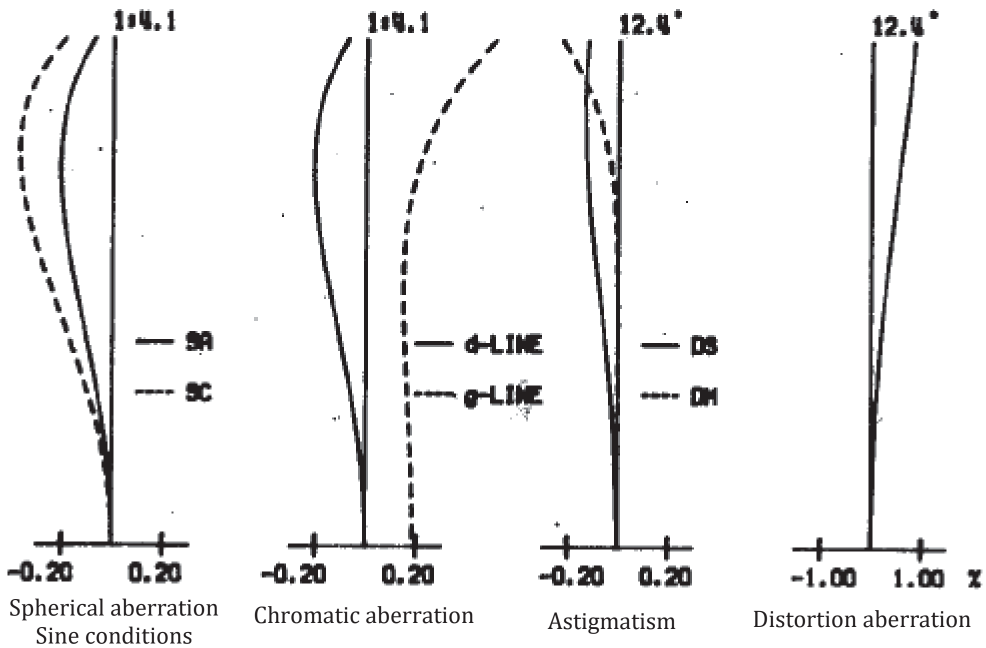

1:4.1
1:4.1
12.4°
12.4°
SA
SC
d-LINE
g-LINE
DS
DM
-0.20
0.20
-0.20
0.20
-0.20
0.20
-1.00
1.00
%
Spherical aberration
Sine conditions
Chromatic aberration
Astigmatism
Distortion aberration

FIG. 7

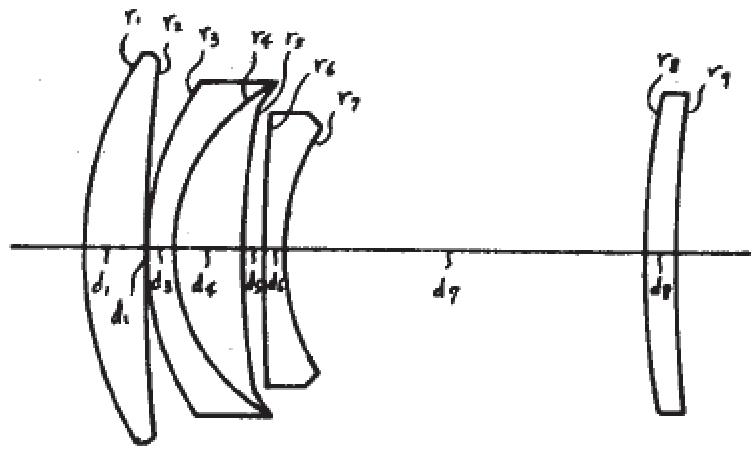
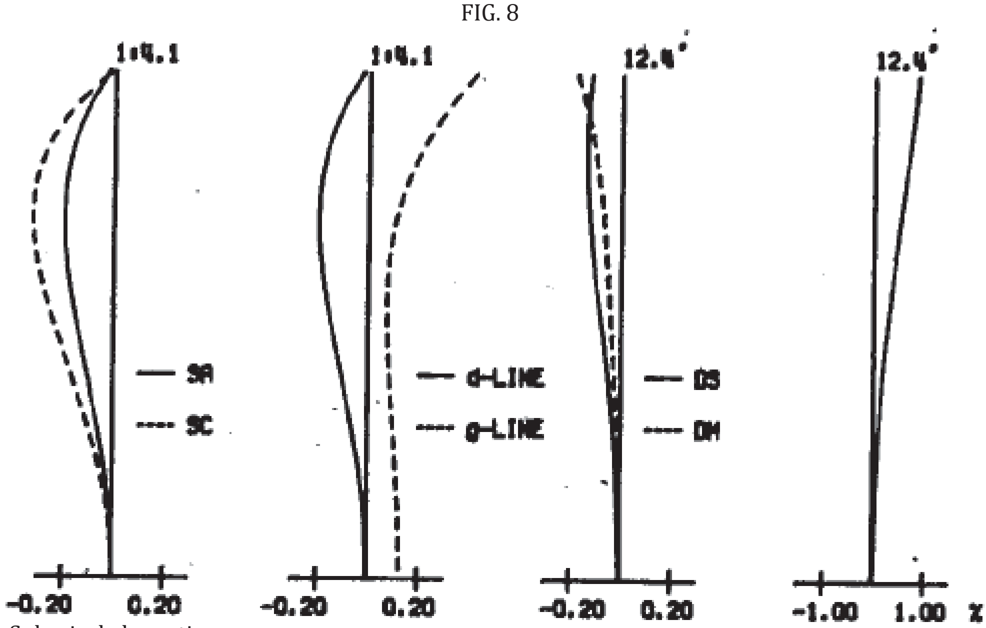


FIG. 8



Spherical aberration
Sine conditions

Chromatic aberration

Astigmatism

Distortion aberration

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

APPLE INC.,

Petitioner,

v.

COREPHOTONICS LTD.,

Patent Owner

DECLARATION OF DAVID BALDWIN

"#!&Ä)Ä*%(' ($ "Ä+%" Ä&",%'

-Ä+3G;6)3>6H;@ÄA:7C74I ?3=7 E:7 8A>>AH;@6 67 5>3C3E;A@'

\# - 3? 8>F7@E4AE:,@9>;D:3@63B3@7D7 >3@9F397D :7C74I 57CE;8I E:3E E:7 8AC79A;@9 6A5F?7@E 3@6 E:7 3EE35:76 EC3@D>3E;A@ ;D 3@ 355FC3E7 EC3@D>3E;A@ 8CA? E:7 AC;9;@3> 6A5F?7@E

B7@3>EI A8 B7C<FCI E:3E - :3G7 EC3@D>3E76 E:7 6A5F?7@E H:;5: ;D 3EE35:76 EA

E:;D +75>3C3E;A@ 3@6 E:3E E:7 3EE35:76 EC3@D>3E;A@ ;D EAE:7 47DE A8 ?I

=@AH>7697 3@6 47>;78 3 ECF7 3@6 355FC3E7 3@6 83;E:8F> EC3@D>3E;A@

$ - 675>3C7 E:3E 3>> DE3E7?7@ED ?367 :7C7;@ A8 ?I AH@ =@AH>7697 3C7 ECF7 3@6

E:3E 3>> DE3E7?7@ED ?367 A@ ;@8AC?3E;A@ 3@6 47>;78 3C7 47>;7G76 EA 47 ECF7

3@6 8FCE:7C E:3E E:7D7 DE3E7?7@ED H7C7 ?367 H;E: E:7 =@AH>7697 E:3E H;>>8F>

83>D7 DE3E7?7@ED 3@6 E:7 >;=7 3C7 BF@;D:34>7 4I 8;@7 AC ;?BC;DA@?7@E AC

4AE:Ä F@67C (75E;A@ #""# A8 0;E>7 #& A8 E:7 1@;E76 (E3E7D *A67

+ 3E7' $!%!$"

+3G;6)3>6H;@

⑲ 日本国特許庁（JP）　⑪ 特許出願公開
⑫ 公開特許公報（A）　昭58—62609

⑤Int. Cl.³	識別記号	庁内整理番号
G 02 B 13/02		7529—2H
// G 02 B 9/34		6952—2H

㊸公開 昭和58年(1983) 4月14日
発明の数 1
審査請求 未請求
（全 5 頁）

⑤望遠レンズ

㉑特　　願　昭56—160716
㉒出　　願　昭56(1981)10月8日

㊷発 明 者　河村憲明
東京都板橋区前野町2丁目36番9号旭光学工業株式会社内
⑪出 願 人　旭光学工業株式会社
東京都板橋区前野町2丁目36番9号

明　細　書

1. 発明の名称　望遠レンズ

2. 特許請求の範囲

物体側より順に、第1レンズは物体側に凸の正メニスカスレンズ、第2レンズと第3レンズは物体側に凸の貼り合わせ面を有する負メニスカスレンズと正メニスカスレンズとの貼り合せ正メニスカスレンズ、第4レンズは像面側に凹の曲率大なる後面を有する負レンズ、第5レンズは正レンズである4群5枚構成レンズにおいて、次の(1)〜(8)の諸条件を満足する収差状況良好な望遠レンズ。

(1) $0.3F < F_{1\cdot2\cdot3} < 0.5F$

(2) $1.0F < F_{1\cdot2\cdot3\cdot4} < 2.5F$

(3) $0.1F < d_1 + d_2 + d_3 + d_4 + d_5 + d_6 < 0.2F$

(4) $0.1F < d_7 < 0.3F$

(5) $30 < \nu_4 < 50$

(6) $0.1F < r_4 < 0.25F$

(7) $0.05 < n_2 - n_3 < 0.3$

(8) $5 < \nu_3 - \nu_2 < 50$

但し、Fは全系の焦点距離、$F_{1\cdot2\cdots i}$は第iレンズ迄の合成焦点距離、n_iは第i番目レンズのd-lineの屈折率、ν_iは第i番目レンズのアッベ数、r_jは第j番目の曲率半径、d_jは第j番目の面間隔である。

3. 発明の詳細な説明

本発明は明るさ1：4程度の中望遠レンズに関するものであり、例えば画面サイズ6×7用の焦点距離200㎜，同4.5×6用の焦点距離150㎜前後のレンズに適用されるものである。レンズタイプは、いわゆるエルノスタータイプで、このタイプは従来、他の収差が良好に補正されたとしても色の球面収差、特にg線付近の短波長光に対する周縁光束の球面収差が、補正過剰となる傾向があつた。また倍率の色収差も比較的大きかつた。

本発明の目的は、全長のコンパクト性は望遠比0.96〜0.88程度の従来並みに止どめるが、基準波長，色の球面収差を共に良好に補正し、また倍率の色収差も小さくすることにより、結像性能において優秀なレンズを提供することである。

先ず本発明のレンズ構成を説明すると、第1レンズは物体側に凸の正メニスカスレンズ、第2レンズと第3レンズは物体側に凸の貼り合わせ面を有する負メニスカスレンズと正メニスカスレンズとの貼り合わせ正メニスカスレンズ、第4レンズは像面側に凹の曲率大なる後面を有する負レンズ、第5レンズは正レンズである4群5枚構成レンズにおいて、次の諸条件を満足する望遠レンズである。

(1) $0.3F < F_{1\cdot 2\cdot 3} < 0.5F$

(2) $1.0F < F_{1\cdot 2\cdot 3\cdot 4} < 2.5F$

(3) $0.1F < d_1 + d_2 + d_3 + d_4 + d_5 + d_6 < 0.2F$

(4) $0.1F < d_7 < 0.3F$

(5) $30 < \nu_4 < 50$

(6) $0.1F < r_4 < 0.25F$

(7) $0.05 < n_2 - n_3 < 0.3$

(8) $5 < \nu_3 - \nu_2 < 50$

符号は次のように定める。

F ：全系の焦点距離

$F_{1\cdot 2\cdots i}$ ：第 i レンズ迄の合成焦点距離

n_i ：第 i 番目レンズの d-line の屈折率

ν_i ：第 i 番目レンズのアッベ数

r_j ：第 j 番目の曲率半径

d_j ：第 j 番目の面間隔

ω ：半画角

以下、上記各条件について説明する。

(1)の条件は、(2)，(3)の条件と関連して、望遠比を0.96～0.88程度とし、収差を良好に補正した望遠レンズの骨格をなすのに必要な焦点距離の配分を示す条件である。上限を超える時には、コンパクト性を保つために第3レンズと第4レンズとの面間隔 d_5 をかなり大きくしなければならず、色収差をはじめ、他の収差を補正するのが容易ではなくなる。また下限を超える時には、第1レンズから第3レンズまでの度に負担がかかるので第1レンズ及び第3レンズの正レンズに屈折率の大きいものを用いなければならず、ペッツバールの和及び硝子の配合等にも困難を生じ、性能を低下させる原因となるものである。

(2)の条件は、(1)の条件下で第4レンズの度を定める条件である。上限を越えて長い $F_{1\cdot 2\cdot 3\cdot 4}$ の時には、ここまでの望遠比が増大するので、コンパクトにするためには第5レンズを出来るだけ接近して配置しなければならず、色収差の補正及び収差バランスを崩してしまう結果となる。また下限を越えて短い時には、第5レンズの度が小さくなりすぎて、第1～第4レンズで発生した諸収差をバランス良く補正出来ない。

(3)の条件は、主にペッツバールの和を正常に保ち、しかも望遠比を目的の範囲に維持するための条件である。上限より大きい時には、望遠比に有利であるが、ペッツバール和には不利となり、また下限より小さい時には、この逆になる。従って、どちらも収差上、目的の画角では満足できないものとなる。

(4)の条件は、第5レンズの位置に関する条件である。上限を越えて d_7 が大きくなると、周辺光量を適正に保つ為には第5レンズの径が大きくなり過ぎ、枠構成上好ましくない。また下限を越えて d_7 が小さくなると、コマ収差が発生し、その補正が容易でなくなるので好ましくない。

(5)の条件は、第4レンズに関するものである。これは(6)，(7)，(8)の条件とも関連して本発明において大きな意味を持つ。一般のエルノスタータイプレンズは、負レンズ1枚にて色補正を担当しているが、本発明のレンズにおいてはさらに1枚負レンズ（第2レンズ）を追加して色補正を分担している。その効果は、従来負レンズで発生していた周縁光束における色収差補正過剰を抑えることが出来たこと、および色補正を分担させたことにより ν_4 が比較的大きい値を取り得ることである。これは2次スペクトルの色収差，倍率色収差を小さくする意味で有効であり、また硝材の分布から見て屈折率の低いものも使用可能となった。この事は他の硝材配分にも効果をもたらした。下限を超えると、上述のように周縁光束の色収差の補正が困難となり、また上限を超えると、第4レンズによる色補正の効果が小さくなり、第4レンズのパワーを相当強くしなければならないが、これは他の収差補正に相当の困難を伴う。

(6)，(7)，(8)の条件は、第2，第3レンズの貼り合わせレンズに関する条件であり、主として第4レンズと共に色収差補正を分担し、且つ、他の収差を適正に保つための条件である。(6)，(7)，(8)の条件は互いに関連を持ちながらこの役割を果す。

(6)の条件は貼り合せ面の曲率半径の範囲を定めたものであるが、上限を越える時には、収差補正上、条件(7)あるいは条件(8)の上限を越す必要を生じ、市販の硝材の範囲で選択すると特殊な硝材を使用する事になり、径の比較的大きいレンズに於ては不適当である。また下限を越えると、貼り合せ面の曲率半径が小さくなりすぎて、製作上の困難さを増すと共に、周辺光束の色収差の補正が困難となる。

(7)の条件は、上限を越えると、条件(6)の範囲では第4面r_4の屈折力が弱くなり過ぎて、本発明の目的とする周辺光束の色収差の補正に不適当であり、また下限を越えると、第2レンズの効果が小さくなり、第2レンズの効果を上げるためには条件(6)の下限あるいは条件(8)の上限を越さなければならず、色収差と他の諸収差をバランスよく補正する事が困難となる。

(8)の条件は、色消し分担の条件で、下限より小さいと、第2レンズの色消し分担が少なすぎ、本発明による効果が現われず不適である。また上限を越える時には、周辺光束の色収差が発生するので好ましくない。

次に本発明の実施例の数値を示す。

実施例1

1 : 4.1　　F = 200.079　　ω = 12.3°

NO.	r	d	N	ν
1	57.091	9.00	1.60311	60.7
2	330.000	0.20		
3	45.039	4.00	1.67270	32.1
4	33.450	9.60	1.48749	70.1
5	81.000	3.50		
6	387.380	3.00	1.57501	41.5
7	34.361	41.80		
8	146.228	4.34	1.74950	35.3
9	552.040			

$F_{1 \cdot 2 \cdot 3} = 74.912$

$F_{1 \cdot 2 \cdot 3 \cdot 4} = 356.466$

$d_1 + d_2 + d_3 + d_4 + d_5 + d_6 = 29.3$

実施例2

1 : 4.1　　F = 199.419　　ω = 12.4°

NO.	r	d	n	ν
1	56.700	8.50	1.60311	60.7
2	263.618	0.2		
3	45.570	5.6	1.66755	41.9
4	30.259	9.0	1.49700	81.6
5	85.200	3.13		
6	353.617	4.28	1.57501	41.5
7	34.500	38.24		
8	129.576	4.34	1.74950	35.3
9	400.000			

$F_{1 \cdot 2 \cdot 3} = 77.277$

$F_{1 \cdot 2 \cdot 3 \cdot 4} = 367.730$

$d_1 + d_2 + d_3 + d_4 + d_5 + d_6 = 30.71$

実施例3

1 : 4.1 F = 199.692 ω = 12.4°

NO.	r	d	n	ν
1	53.134	8.50	1.58913	61.0
2	216.482	0.20		
3	42.882	4.00	1.80610	40.9
4	27.695	10.00	1.61800	63.4
5	101.862	3.00		
6	215.992	4.81	1.72000	42.0
7	31.982	42.70		
8	103.244	4.34	1.64769	33.8
9	231.664			

$F_{1\cdot2\cdot3} = 64.069$

$F_{1\cdot2\cdot3\cdot4} = 319.118$

$d_1 + d_2 + d_3 + d_4 + d_5 + d_6 = 30.51$

実施例4

1 : 4.1 F = 199.767 ω = 12.4°

NO.	r	d	n	ν
1	50.041	8.50	1.60311	60.7
2	218.067	0.20		
3	39.842	3.72	1.69680	55.5
4	25.661	9.50	1.51633	64.1
5	102.728	2.95		
6	275.049	2.79	1.63980	34.5
7	31.011	49.89		
8	107.040	4.34	1.78472	26.6
9	175.118			

$F_{1\cdot2\cdot3} = 63.147$

$F_{1\cdot2\cdot3\cdot4} = 296.461$

$d_1 + d_2 + d_3 + d_4 + d_5 + d_6 = 27.66$

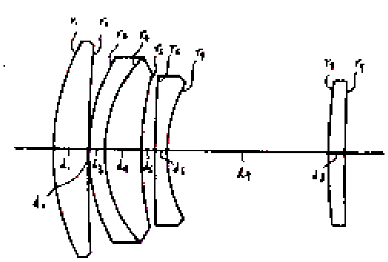
4. 図面の簡単な説明

第1，3，5，7図はそれぞれ本発明の実施例1，2，3，4に対応するレンズ系構成図，第2，4，6，8図はそれぞれ実施例1，2，3，4に対応する収差曲線図である。

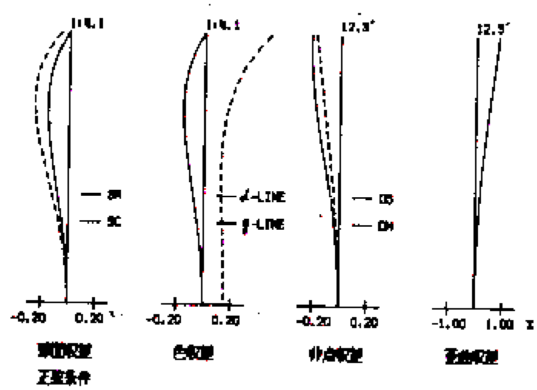
特許出願人 旭光学工業株式会社

代表者 松本 徹

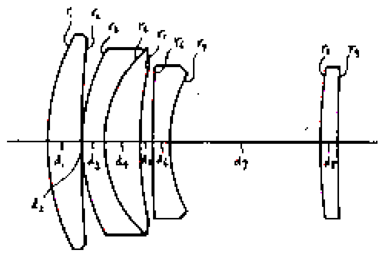
第1図



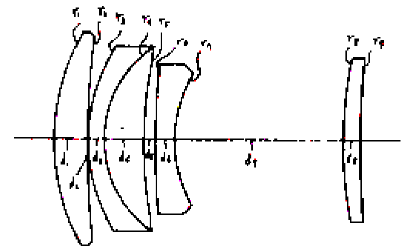
第2図



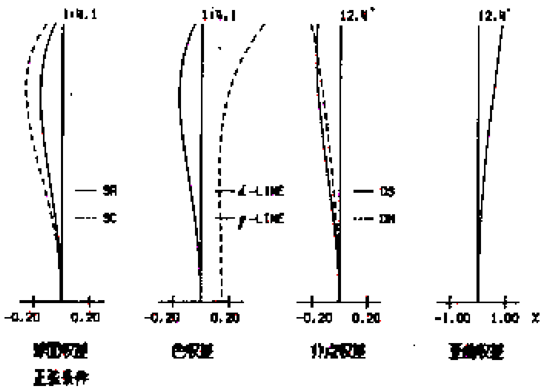
第3図



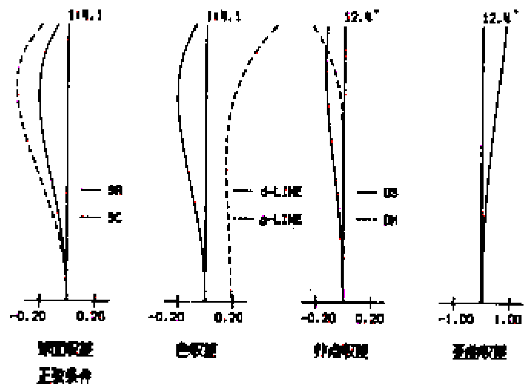
第5図



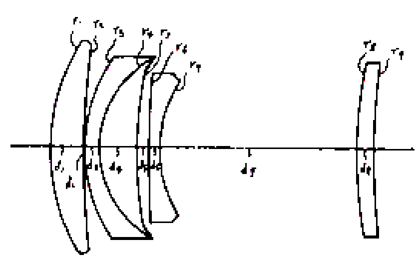
第4図



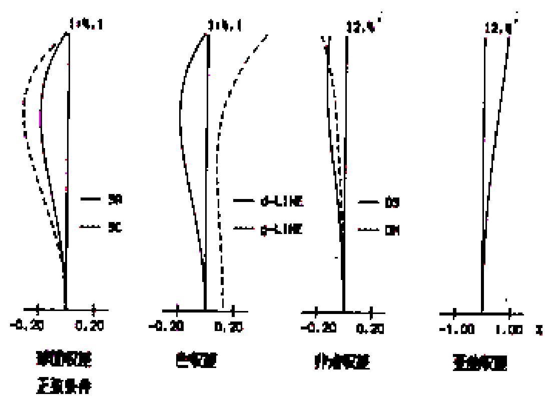
第6図



第7図



第8図



US008553106B2

(12) **United States Patent**
Scarff

(10) **Patent No.: US 8,553,106 B2**
(45) **Date of Patent: Oct. 8, 2013**

(54) **DUAL LENS DIGITAL ZOOM**

(75) Inventor: **Lawrence Scarff**, Burlington, MA (US)

(73) Assignee: **DigitalOptics Corporation**, San Jose, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 461 days.

(21) Appl. No.: **12/435,080**

(22) Filed: **May 4, 2009**

(65) **Prior Publication Data**

US 2010/0277619 A1 Nov. 4, 2010

(51) **Int. Cl.**
H04N 5/262 (2006.01)
H04N 9/093 (2006.01)

(52) **U.S. Cl.**
USPC **348/240.2**; 348/263

(58) **Field of Classification Search**
USPC 348/262, 263, 240.99–240.2, 218.1
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,697,573 B1	2/2004	Adkins	
2002/0195548 A1	12/2002	Dowski, Jr. et al.	
2003/0020814 A1	1/2003	Ono	
2006/0001757 A1	1/2006	Sawachi	
2006/0187338 A1*	8/2006	May et al.	348/375
2006/0204034 A1	9/2006	Steinberg et al.	
2007/0120988 A1*	5/2007	Akiyama et al.	348/240.99
2008/0030592 A1	2/2008	Border et al.	
2008/0218612 A1	9/2008	Border et al.	
2009/0128644 A1	5/2009	Camp, Jr. et al.	
2010/0238327 A1	9/2010	Griffith et al.	

FOREIGN PATENT DOCUMENTS

JP	10-262175	A	9/1998
JP	2004-297332	A	10/2004
JP	2005-198155	A	7/2005
JP	2008-268937	A	11/2008
WO	02-08685	A2	1/2002
WO	2008-112054	A1	9/2008

OTHER PUBLICATIONS

Webpage http://imaginatorium.org/stuff/angle.htm as seen on Feb. 8, 2007 via the WayBack Machine (http://wayback.archive.org), URL: http://web.archive.org/web/20070208160219/http://www.imaginatorium.org/stuff/angle.htm.*

CN Application No. 201010170111.9, Office Action dated Dec. 12, 2011 (English translation).

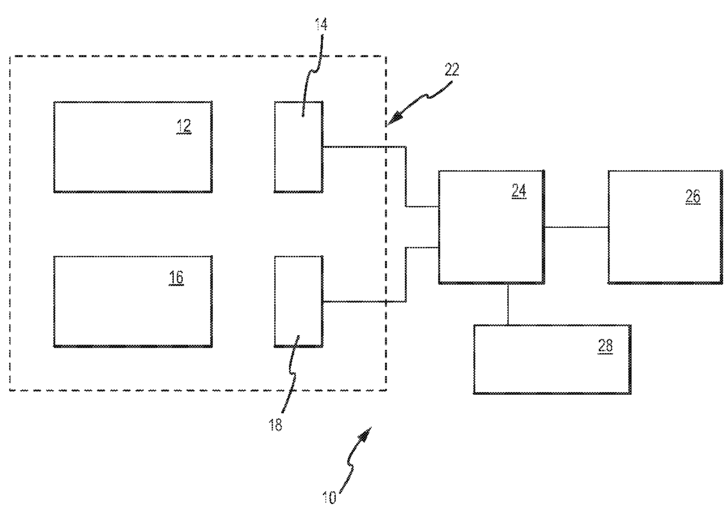
(Continued)

Primary Examiner — Daniel M Pasiewicz
Assistant Examiner — Mark Monk
(74) *Attorney, Agent, or Firm* — Larry E. Henneman, Jr.; Gregory P. Gibson; Henneman & Associates, PLC

(57) **ABSTRACT**

A camera with a pair of lens/sensor combinations, the two lenses having different focal lengths, so that the image from one of the combinations has a field of view approximately two to three times greater than the image from the other combination. As a user of the camera requests a given amount of zoom, the zoomed image provided will come from the lens/sensor combination having the field of view that is next larger than the requested field of view. Thus, if the requested field of view is less than the smaller field of view combination, the zoomed image will be created from the image captured by that combination, using cropping and interpolation if necessary. Similarly, if the requested field of view is greater than the smaller field of view combination, the zoomed image will be created from the image captured by the other combination, using cropping and interpolation if necessary.

15 Claims, 1 Drawing Sheet

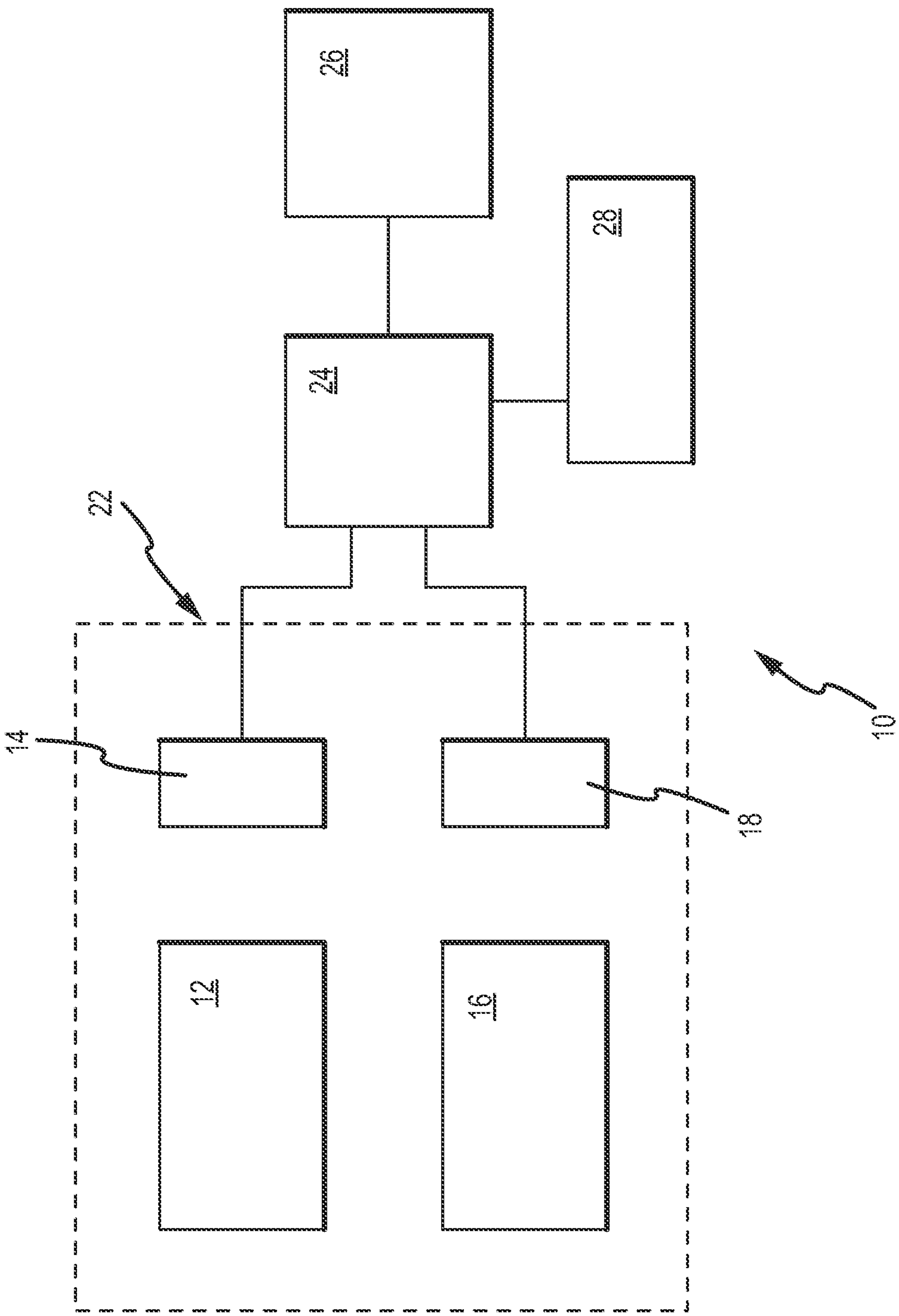


(56) **References Cited**

OTHER PUBLICATIONS

CN Application No. 201010170111.9, Office Action dated Sep. 20, 2012 (English translation).
U.S. Appl. No. 12/727,973, Office Action dated Apr. 4, 2012.
U.S. Appl. No. 12/727,973, Office Action dated Nov. 20, 2012.
U.S. Appl. No. 12/727,973, Notice of Allowance dated May 10, 2013.
PCT Application No. PCT/US10/28014, International Search Report dated Oct. 27, 2010.
PCT Application No. PCT/US10/28014, International Preliminary Report on Patentability dated Sep. 20, 2011.
JP Application No. 2012-501003, Office Action dated Aug. 6, 2013 (English translation).
CN Application No. 201010170111.9, Notice of Allowance dated Jun. 13, 2013 (English translation).
JP Application No. 2010-81264, Office Action dated Jul. 30, 2013 (English translation).
U.S. Appl. No. 12/727,973, Corrected Notice of Allowance dated Aug. 5, 2013.

* cited by examiner


26
28
24
22
10
14
18
12
16

DUAL LENS DIGITAL ZOOM

BACKGROUND

Digital camera modules are currently being incorporated into a variety of host devices. Such host devices include cellular telephones, personal data assistants (PDAs), computers, and so forth. Consumer demand for digital camera modules in host devices continues to grow.

Host device manufacturers prefer digital camera modules to be small, so that they can be incorporated into the host device without increasing the overall size of the host device. Further, there is an increasing demand for cameras in host devices to have higher-performance characteristics. One such characteristic that many higher-performance cameras (e.g., standalone digital still cameras) have is the ability to vary the focal length of the camera to increase and decrease the magnification of the image, typically accomplished with a zoom lens, now known as optical zooming. Optical zooming is typically accomplished by mechanically moving lens elements relative to each other, and thus such zoom lens are typically more expensive, larger, and less reliable than fixed focal length lenses. An alternative approach for approximating this zoom effect is achieved with what is known as digital zooming. With digital zooming, instead of varying the focal length of the lens, a processor in the camera crops the image and interpolates between the pixels of the captured image to create a “magnified” but lower-resolution image.

There have been some attempts to use two different lenses to approximate the effect of a zoom lens. It has been done in the past with film cameras in which the user could select one of two different focal lengths to capture an image on film. More recently, a variation on this concept with camera modules has been disclosed in U.S. Pat. Pub. No. 2008/0030592, the entire contents of which are incorporated herein by reference, which discusses a camera module with a pair of sensors, each having a separate lens through which light is directed to the respective sensor. In this publication, the two sensors are operated simultaneously to capture an image. The respective lenses have different focal lengths, so even though each lens/sensor combination is aligned to look in the same direction, each will capture an image of the same subject but with two different fields of view. The images are then stitched together to form a composite image, with the central portion of the composite image being formed by the relatively higher-resolution image taken by the lens/sensor combination with the longer focal length and the peripheral portion of the composite image being formed by a peripheral portion of the relatively lower-resolution image taken by the lens/sensor combination with the shorter focal length. The user selects a desired amount of zoom and the composite image is used to interpolate values therefrom to provide an image with the desired amount of zoom. Unfortunately, the disclosure in this publication is largely conceptual and lacks in certain details that would be needed to provide optimal performance. U.S. Pat. App. No. 61/161,621, the entire contents of which are incorporated herein by reference, discloses improvements and refinements to this concept.

The foregoing examples of the related art and limitations related therewith are intended to be illustrative and not exclusive. Other limitations of the related art will become apparent to those of skill in the art upon a reading of the specification and a study of the drawings.

SUMMARY

Disclosed herein is a camera operated by a user that includes a first sensor that captures a first image; a first lens that directs light to the first sensor, the first lens having a first focal length, wherein the combination of the first sensor and first lens has a first field of view; a second sensor that captures a second image; a second lens that directs light to the second sensor, the second lens having a second focal length that is longer than the first focal length, wherein the combination of the second sensor and second lens has a second field of view, wherein the first field of view is greater than the second field of view; and a zoom control operable by the user to allow the user to request a desired field of view to produce a zoomed image. The combination of the first sensor and the first lens are substantially aligned with the combination of the second sensor and the second lens to allow each to be directed toward the same subject. The zoomed image is the first image if the requested field of view is substantially equal to the first field of view, the zoomed image is produced from the first image by cropping and interpolating the first image if the requested field of view is less than the first field of view and greater than the second field of view, the zoomed image is the second image if the requested field of view is substantially equal to the second field of view, and the zoomed image is produced from the second image by cropping and interpolating the second image if the requested field of view is less than the second field of view.

The camera may further include a third sensor that captures a third image; a third lens that directs light to the third sensor, the third lens having a third focal length that is longer than the second focal length, wherein the combination of the third sensor and third lens has a third field of view, wherein the second field of view is greater than the third field of view. The combination of the third sensor and the third lens may be substantially aligned with the combination of the first sensor and the first lens and the combination of the second sensor and the second lens to allow each to be directed toward the same subject. The zoomed image may be the first image if the requested field of view is substantially equal to the first field of view, the zoomed image may be produced from the first image by cropping and interpolating the first image if the requested field of view is less than the first field of view and greater than the second field of view, the zoomed image may be the second image if the requested field of view is substantially equal to the second field of view, the zoomed image may be produced from the second image by cropping and interpolating the second image if the requested field of view is less than the second field of view and greater than the third field of view, the zoomed image may be the third image if the requested field of view is substantially equal to the third field of view, and the zoomed image may be produced from the third image by cropping and interpolating the third image if the requested field of view is less than the third field of view.

The first field of view may be approximately twice that of the second field of view. The first field of view may be in the range of approximately two to three times that of the second field of view. The zoom control may be used to request a zoomed image in a range, with one end of the range corresponding approximately to the first field of view and the opposite end of the range corresponding approximately to ¼ to ½ of the second field of view.

Also disclosed is a camera operated by a user that includes a sensor that captures an image; a first lens that can direct light to the sensor, the first lens having a first focal length, wherein the combination of the sensor and first lens has a first field of view; a second lens that can direct light to the sensor, the second lens having a second focal length that is longer than the first focal length, wherein the combination of the sensor and second lens has a second field of view, wherein the first field of view is greater than the second field of view; and a

zoom control operable by the user to allow the user to request a desired field of view to produce a zoomed image. The first and second lenses can be moved relative to the sensor into one of two different positions so that the sensor can receive either light passing through the first lens or light passing through the second lens. The combination of the sensor and the first lens are substantially aligned with the combination of the sensor and the second lens to allow either to be directed toward the same subject. The zoomed image is the image from the first sensor if the requested field of view is substantially equal to the first field of view, the zoomed image is produced from the image from the first sensor by cropping and interpolating the image from the first sensor if the requested field of view is less than the first field of view and greater than the second field of view, the zoomed image is the image from the second sensor if the requested field of view is substantially equal to the second field of view, and the zoomed image is produced from the image from the second sensor by cropping and interpolating the image from the second sensor if the requested field of view is less than the second field of view.

The first field of view may be approximately twice that of the second field of view. The first field of view may be in the range of approximately two to three times that of the second field of view. The zoom control may be used to request a zoomed image in a range, with one end of the range corresponding approximately to the first field of view and the opposite end of the range corresponding approximately to ¼ to ½ of the second field of view. The lenses may be moved relative to the sensor manually by the user. The lenses may be moved relative to the sensor automatically by the camera when the field of view requested by the user changes between using the image from one of the combinations to the other of the combinations.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram of a camera.

DETAILED DESCRIPTION

The following description is not intended to limit the invention to the form disclosed herein. Consequently, variations and modifications commensurate with the following teachings, and skill and knowledge of the relevant art, are within the scope of the present invention. The embodiments described herein are further intended to explain modes known of practicing the invention and to enable others skilled in the art to utilize the invention in such, or other embodiments and with various modifications required by the particular application(s) or use(s) of the present invention.

A camera **10** is shown in FIG. **1**. The camera **10** may include a first lens **12** having a relatively-shorter focal length and a first sensor **14** that are located proximate to and substantially aligned with a second lens **16** having a relatively-longer focal length and a second sensor **18**. By having the combined first lens and first sensor aligned with the combined second lens and second sensor, the sensors can each obtain an image of substantially the same subject. Of course, due to the different focal lengths of the lenses **12** and **16**, the first sensor **14** will obtain an image of the subject with a relatively-wider field of view (FOV) as compared to the relatively-narrower FOV of the image obtained by the second sensor **18**. In one example, the first FOV may be in the range of two to three times as large as the second FOV. In another example, the first FOV may be approximately twice the second FOV.

In most cases, each sensor **14** and **18** may perform certain basic image processing algorithms such as white balancing, and so forth. The lenses **12** and **16** could be made of any acceptable material, including plastic (e.g., injection-molded plastic), glass, optical ceramic, diffractive elements, or a composite.

In one example, the lens **16** may be a lens having a focal length of 7.2 mm and a field-of-view (FOV) of 32 degrees, while the lens **12** may be a lens having a focal length of 3.62 mm and an FOV of 63 degrees. These lens specifications are merely exemplary and any other suitable lens characteristics could be acceptable. In addition, one or both of the lenses **12** and **16** could be variable focal length (zoom) lenses.

In one example, the two lenses **12** and **16** may have the same f-number so that the illuminance of the light received at the sensors **14** and **18** is equivalent. With equivalent illuminance, the sensors can be operated at similar levels of amplification and with similar exposure times. In this manner, the separate images captured by the separate sensors **14** and **18** can be of similar levels of brightness and contrast. By having similar levels of amplification, the background noise in each image will be similar. By having similar exposure times, artifacts in each image due to subject motion will be similar. By maintaining similarity as to these two characteristics in the two images, transitions between the two images will be more acceptable to the user. In another example, the lenses **12** and **16** may be chosen to provide the same depth of field for each lens/sensor combination.

In one example, each of the sensors is a Bayer sensor, which uses a color filter array over the array of separate pixels, as is well known. Such sensors sense green light at every other pixel, with the intervening pixels alternating between red pixels and blue pixels. The raw sensed signals are later provided to a demosaicing algorithm, which interpolates between the pixels to obtain a full color signal for each pixel. However, the invention is not limited to use with a Bayer sensor and will work equally well with sensors having a different color filter array, cameras based on time-sequential color, cameras using beamsplitters and separate sensors for each color channel, and other camera architectures.

In some cases, the camera **10** may be considered to include only the functional portions described above. In other cases, these portions (referred to collectively as a camera module **22**) may also be combined with certain downstream components as part of the camera **10**. In such case, the camera **10** may also include an image signal processor (ISP) **24**, a display **26**, and user interface controls **28**. Of course, as is well known in the camera industry, cameras may also typically include several other components that are omitted here for simplification. For example, as non-limiting examples, these other components may include batteries, power supplies, an interface for the application of external power, a USB or other interface to a computer and/or printer, a light source for flash photography, auto-focus and image stability controls, internal memory, one or more ports for receiving an external memory card or device (e.g., an SD or xD memory card), and in the case of the use of a camera in a mobile phone, a microphone, speaker, transmitter/receiver, and an interface for an external microphone and speaker (e.g., a Bluetooth headset).

The user interface controls **28** may include conventional controls that are used to operate the camera, including controls to instruct the camera to capture one or more images, as well as to manipulate the images, and many other functions. One of the controls allows the user to digitally zoom the camera to increase or decrease the field of view (FOV) of the camera. The user can zoom the image out to the FOV of the image from the first sensor **14** at one end of the zooming range and to a point that may be somewhere between ½ and ¼ of the FOV of the image from the second sensor **18** at the other end

of the zooming range. The zoomed image may simply be the first image if the requested field of view is substantially equal to the first field of view. The zoomed image is produced from the first image by cropping and interpolating the first image if the requested field of view is less than the first field of view and greater than the second field of view. The zoomed image is the second image if the requested field of view is substantially equal to the second field of view. The zoomed image is produced from the second image by cropping and interpolating the second image if the requested field of view is less than the second field of view.

The zooming range may be limited on one end by the FOV of the first sensor. Although the camera **10** could be designed to allow the user to continue to zoom out to a "FOV" greater than that of the first lens/sensor, the image would in fact get smaller as the image from the first sensor was merely shrunk in size and no extra image information would be brought at the margins of the image, because there is no wider FOV image data to use. The zooming range may be limited on the opposite end by the amount of digital zooming that is deemed to be acceptable to users. Due to the image interpolation that occurs, it may be desirable to limit the digital zooming to a FOV that is somewhere between ½ and ¼ of the FOV of the image from the second sensor **18**.

Alternatively, the camera module **22** could include one or more ISPs located thereon. They could be separate from or integrated into the sensors. Further, while the lenses **12** and **16** described herein are fixed focal length, either or both could be variable focal length (zoom) lenses.

Alternatively, the camera **10** could be provided with a third lens/sensor combination that is aligned with the first two lens/sensor combinations. This third lens/sensor combination may have a field of view that is still smaller than that of the second lens/sensor combination. As the camera was zoomed by the user, the zoomed image would transition between being formed from the first image, the second image, and the third image in a similar manner to that described above. In such case, the zoom range might be from the field of view of the first lens/sensor combination to ½ to ¼ of the field of view of the third lens/sensor combination.

As another alternative, there may be only one sensor and the two (or more) lenses may be moved relative to the sensor to allow an image to be captured from either the combination of the first lens and the one sensor or from the combination of the second lens and the one sensor. This relative movement of the lenses and sensor could be achieved by the user sliding or actuating some type of mechanical member associated therewith or it could be achieved by the camera automatically moving the lenses relative to the sensor when the requested amount of zooming causes the zoomed image to switch from coming from one combination to coming from the other combination. As a further variation to all of this, instead of moving the lenses or sensor, the light path could be redirected by a mirror or the like to cause light from a selected lens to impinge upon the sensor.

Any other combination of all the techniques discussed herein is also possible. The foregoing description has been presented for purposes of illustration and description. Furthermore, the description is not intended to limit the invention to the form disclosed herein. While a number of exemplary aspects and embodiments have been discussed above, those of skill in the art will recognize certain variations, modifications, permutations, additions, and sub-combinations thereof. It is therefore intended that the following appended claims and claims hereafter introduced are interpreted to include all such variations, modifications, permutations, additions, and sub-combinations as are within their true spirit and scope.

The invention claimed is:

1. In a camera operated by a user, a method comprising:

capturing a first image with a first sensor;

directing light to the first sensor with a first lens, the first lens having a first fixed focal length, wherein the combination of the first sensor and first lens has a first field of view;

capturing a second image with a second sensor;

directing light to the second sensor with a second lens, the second lens having a second fixed focal length that is longer than the first fixed focal length, wherein the combination of the second sensor and second lens has a second field of view, wherein the first field of view is greater than the second field of view; and

using a zoom control operable by the user to allow the user to request a desired field of view to produce a zoomed image;

wherein the combination of the first sensor and the first lens are aligned with the combination of the second sensor and the second lens to allow each to be directed toward the same subject;

wherein the zoomed image comprises the first image if the requested field of view is equal to the first field of view, the zoomed image is produced from the first image by cropping and interpolating the first image if the requested field of view is less than the first field of view and greater than the second field of view, the zoomed image comprises the second image if the requested field of view is equal to the second field of view, and the zoomed image is produced from the second image by cropping and interpolating the second image if the requested field of view is less than the second field of view; and

wherein the depth of field for the combination of the first sensor and the first lens is the same as the depth of field for the combination of the second sensor and the second lens.

2. The method of claim **1**, further including:

capturing a third image with a third sensor; and

directing light to the third sensor with a third lens, the third lens having a third fixed focal length that is longer than the second fixed focal length, wherein the combination of the third sensor and third lens has a third field of view, wherein the second field of view is greater than the third field of view;

wherein the combination of the third sensor and the third lens are aligned with the combination of the first sensor and the first lens and the combination of the second sensor and the second lens to allow each to be directed toward the same subject;

wherein the zoomed image comprises the first image if the requested field of view is equal to the first field of view, the zoomed image is produced from the first image by cropping and interpolating the first image if the requested field of view is less than the first field of view and greater than the second field of view, the zoomed image comprises the second image if the requested field of view is equal to the second field of view, the zoomed image is produced from the second image by cropping and interpolating the second image if the requested field of view is less than the second field of view and greater than the third field of view, the zoomed image comprises the third image if the requested field of view is equal to the third field of view, and the zoomed image is produced from the third image by cropping and interpolating the third image if the requested field of view is less than the third field of view.

3. The method of claim **1**, wherein the first field of view is twice that of the second field of view.

4. The method of claim **1**, wherein the first field of view is in the range of two to three times that of the second field of view.

5. The method of claim **1**, wherein the zoom control can be used to request the zoomed image in a range, with one end of the range corresponding to the first field of view and the opposite end of the range corresponding to ¼ to ½ of the second field of view.

6. In a camera operated by a user, a method comprising:

capturing a first and second image with a first and second sensor, respectively;

directing light to the first and second sensors with a first and second fixed focal length lens, respectively, wherein the combination of the first sensor and first lens has a first field of view and the combination of the second sensor and second lens has a second field of view, wherein the second fixed focal length is longer than the first fixed focal length and the first field of view is greater than the second field of view; and

using a zoom control that is operable by the user to allow the user to request a desired field of view to produce a zoomed image;

wherein the combination of the first sensor and the first lens are aligned with the combination of the second sensor and the second lens to allow each to be directed toward the same object;

wherein the zoomed image is produced from the first image or the second image based on the size of the requested field of view relative to the size of the second field of view; and

wherein the depth of field for the combination of the first sensor and the first lens is the same as the depth of field for the combination of the second sensor and the second lens.

7. The method of claim **6**, wherein the zoomed image is produced without any physical movement of the first lens relative to the first sensor or of the second lens relative to the second sensor.

8. The method of claim **6**, wherein if the requested field of view is larger than the second field of view, the zoomed image is produced from the first image.

9. The method of claim **8**, wherein if the requested field of view is equal to or smaller than the second field of view, the zoomed image is produced from the second image.

10. The method of claim **6**, wherein if the requested field of view is equal to or smaller than the second field of view, the zoomed image is produced from the second image.

11. In a camera operated by a user, a method comprising:

capturing a first and second image with a first and a second sensor, respectively;

directing light to the first and second sensors with a first and a second lens, respectively, wherein the combination of the first sensor and first lens has a first field of view and the combination of the second sensor and second lens has a second field of view, wherein the focal length of the second lens is longer than the focal length of the first lens and the first field of view is greater than the second field of view; and

using a zoom control that is operable by the user to allow the user to request a desired field of view to produce a zoomed image;

wherein the combination of the first sensor and the first lens are aligned with the combination of the second sensor and the second lens to allow each to be directed toward the same object;

wherein the zoomed image is produced from the first image or the second image based on the size of the requested field of view relative to the size of the second field of view;

wherein the zoomed image is produced without any physical movement of the first lens relative to the first sensor or of the second lens relative to the second sensor; and

wherein the depth of field for the combination of the first sensor and the first lens is the same as the depth of field for the combination of the second sensor and the second lens.

12. The method of claim **11**, wherein each of the first and the second lens have a fixed focal length.

13. The method of claim **11**, wherein if the requested field of view is larger than the second field of view, the zoomed image is produced from the first image.

14. The method of claim **13**, wherein if the requested field of view is equal to or smaller than the second field of view, the zoomed image is produced from the second image.

15. The method of claim **11**, wherein if the requested field of view is equal to or smaller than the second field of view, the zoomed image is produced from the second image.

* * * * *

3 "**matching scale**" and "**to match brightness and color**" respectively).

VI. CLAIM 5 IS OBVIOUS OVER GOLAN IN COMBINATION WITH KAWAMURA.

A. Patent Owner mischaracterizes Golan as limited to miniature cameras using miniature lenses.

15. A POSITA would have understood that Golan's teachings are not limited to miniature cameras. Patent Owner's no motivation to combine arguments are based on the incorrect understanding that Golan is limited to miniature cameras using miniature lenses.

1. Golan's teachings include non-miniature cameras using non-miniature lenses.

16. A POSITA would have understood that Golan's teachings are not limited to miniature cameras used in mobile devices such as cellphones, and instead include applications for conventional digital still cameras and other commercial, industrial and security applications including air-born vehicles/drones applications. Specifically, Golan never mentions "miniature," and does not have any dimension limitation on either its imaging system or image sensors, and as such, a POSITA would have understood that Golan's teachings apply to imaging systems of various sizes using any suitable image sensors.

17. A POSITA's understanding of the applicability of Golan's teachings to applications other than only mobile devices is confirmed by other disclosures from Golan's inventors and assignee, NextVision Stabilized Systems Ltd.

("NextVision"). For example, another patent by the same inventors with the same assignee, the '697 patent, describes "an imaging system, operatively mounted on an air-born vehicle." (APPL-1022), '697 Patent, 1:14-18. *See also* APPL-1034 (approximately 4:04 minutes of video capture including (0:00-0:50min) authenticating flash content as retrieved from an archive.org crawl of the nextvision-sys.com website of September 2, 2012, (0:50-1:22min) depicting Nextvision and MicroCam-D (e.g., with 8.8X zoom), (1:22min) video feed from MicroCam-D on a flying drone including examples of digital zoom at 2:42min and 3:21min); APPL-1035 (captured from APPL-1034 at 0:52min and reproduced below illustrating dimensions of MicroCam-D); (APPL-1024), Eshel, 2 (describing a 145cm long (4.76 ft) unmanned aviation vehicle using "stabilized daylight MicroCam D from Nextvision"); (APPL-1026), NextVision MicroCam-D (describing MicroCam-D at 130 grams (4.6 oz) with a dimension of 70mm x 80mm); (APPL-1030), UAS VISION, 2 (describing NextVision products as an example of lightweight payloads for lightweight unmanned aircraft systems (UAS)).

2. Patent Owner's mischaracterization of Golan is based on its improper reliance on Golan's example 5-Megapixel image sensor.

18. Patent Owner argues a POSITA would not have used the Kawamura lens unmodified in Golan because of Golan's use of "a tiny 5 megapixel sensor."

Response, 33. Patent Owner further argues that a POSITA would not have scaled the Kawamura lens to Golan because "the Kawamura lens would need to be scaled down by a factor of around 14x to 20x in order to provide the same field of view on a 5 megapixel sensor," and such "scaling of conventional lens designs to miniature size is impractical." Response, 34, 37. Patent Owner's arguments improperly rely on Golan's example 5-Megapixel image sensor as a requirement, and fail to recognize that a POSITA would have used other sensors (e.g., of different megapixel number or different dimensions) in Golan's systems. Contrary to Patent Owner's argument, scaling to accommodate a sensor size was practical and with the skill of a POSITA.

19. Golan provides, "**[f]or example**, having a 5 Megapixel, 2592x1944, image sensor array and an output resolution frame of 400x300 yields maximal lossless electronic zoom of 6.48." Golan, [0004]. A POSITA would have understood that Golan's description of the 5-megapixel image sensor array is merely an example, not a requirement.

20. Patent Owner states, without providing a citation, "even Apple's expert agrees, using Kawamura's lenses in Golan would require scaling it down by more than a factor of 10." Response, 2. I did not provide such agreement. As I explained at the deposition, scaling is "depending on the choice of image sensors," and scaling down the lens prescriptions in Kawamura down by a factor of roughly

ten for an example 5-megapixel sensor in Golan is only "one possibility." EX. 2005, 47:15-17; 49:4-18.

21. Furthermore, even if Golan were limited to a 5-megapixel sensor, Patent Owner's argument that this requires 1/4" or 1/3" sensor format based on its reference to a 5-megapixel sensor is incorrect. A POSITA would have understood that image sensors of different dimensions, for example, a 1/2.5" sensor, may be used in Golan. *See* (APPL-1029), Kodak EasyShare V610, 62 (describing using a 1/2.5" CCD image sensor in a dual lens digital camera to provide a 5.3-megapixel image).

3. Patent Owner's mischaracterization of Golan is further based on its misunderstanding of how Golan achieves "light weight electronic zoom."

22. Patent Owner argues that Golan uses miniature digital sensors (1/4 inch or 1/3 inch in diagonal dimension) "to achieve its stated goals of light weight and low cost." Response, 1. Patent Owner's argument is based on its misunderstanding of how Golan achieves "light weight electronic zoom."

23. Golan describes that a camera with a single optical zoom lens having a large dynamic zoom range typically requires "heavy and expensive lenses." Golan, [0007]. An example of such a heavy and expensive lens is a Fujinon A36X14.5 lens, an optical zoom lens providing a zoom ratio of 36x. (APPL-1027), Fujinon 36X Lenses, 1. The Fujinon A36X14.5 lens is heavy with a weight

of 4.58kg (about 10 pounds) and a length of 363.3 mm (about 14.3"), and is expensive (e.g., a used one priced on eBay for over $10,000). (APPL-1027), Fujinon 36X Lenses, 1; (APPL-1028), Fujinon 36X Lens Ebay Listing, 1.

24. To achieve "light weight electronic zoom," Golan replaces a single optical zoom lens with two fixed focal length lenses and "two (or more) image sensors, having different fixed FOV" to achieve light weight electronic zoom with a large lossless zooming range. Golan, [0009].

25. A POSITA would have understood that, in Golan, the terms "heavy," "expensive," and "light weight" are relative. For example, compared to a camera with a single Fujinon A36X14.5 lens, according to Golan's teachings, a POSITA could and would have achieved light weight digital zoom of 36x by using a wide lens and a telephoto lens (e.g., based on Kawamura's lens design) that are **cheaper** and **lighter** than the Fujinon A36X14.5 lens. As such, Golan does not require using 1/4" or 1/3" miniature digital sensors to achieve a cheaper lightweight digital zoom.

B. A POSITA would have looked to the Kawamura design in selecting a design for Golan's telephoto lens.

1. Patent Owner's no motivation to combine arguments are based on misunderstanding of "heavy" and "lightweight" in Golan and based on incorrect calculation of the scaling factor for using a Kawamura lens in Golan.

26. Patent Owner argues that, a POSITA would not have been motivated

to utilize Kawamura in Golan because "the goal of Golan was to avoid 'heavy and expensive lenses'," and in the context of camera design, "the 7-inch Kawamura lenses would have been considered 'heavy'." Response, 32. Patent Owner's argument is based on misunderstanding of Golan's description of "heavy," "expensive," and "light weight," and how Golan achieves "light weight electronic zoom."

27. As discussed above at IV.A.3, in Golan, the terms "heavy," "expensive," and "light weight" are relative. As such, compared to a camera with a single optical zoom lens (e.g., Fujinon A36X14.5 lens), in the combination of Golan and Kawamura, a POSITA would have achieved light weight digital zoom of 36x by using a wide lens and a telephoto lens based on Kawamura's lens design that are cheaper and lighter than that single optical zoom lens. Dr. Moore estimates that a Kawamura lens would weight about 8.88 ounces (EX2003, ¶63), which is about 252 grams. As such, for the combination of Golan and Kawamura, using an unmodified Kawamura lens (e.g., 252 grams as estimated by Dr. Moore) and a wide-field lens (usually weighs about or the same as the tele lens given that it would be shorter), the weight of both telephoto lens and wide-field lens would weight about 500 grams (0.5 kg) based on Dr. Moore's estimate, which is much lighter than a 36X Fujinon zoom lens of 4.5 Kg.

28. Patent Owner further argues that a POSITA would not have used

Kawamura unmodified in Golan because Golan's sensors dimensions are much smaller than a 56mm x 67mm film size of Kawamura. Response, 34. However, not only that Golan does not have any sensor dimension limitations as explained at V.A, when applying Golan's teachings, a POSITA would have used image sensors of various dimensions, including sensors with sizes similar to a film size of Kawamura, that are suitable for applications. *See, e.g.*, (APPL-1031), Sun, 2:31-45 (describing using a 60mm x 45mm image sensor in applications including unmanned aerial vehicles); (APPL-1032), Elgersma, 1:10, 25-26 (using a 24 mm x 36 mm image sensor in applications including unmanned aerial vehicles).

29. Patent Owner argues a POSITA would not have been motivated to scale Kawamura because "Kawamura lens would need to be scaled down by a factor of around 14x to 20x in order provide the same field of view on a 5-megapixel sensor," and because allegedly "scaling lens designs by a large factor is not done in practice." Response, 34. Patent Owner's requirement for such a large scaling factor is incorrect because it is based on an example 5-megapixel sensor of Golan and unwarranted presumptions regarding the dimensions of such a sensor, and ignores other possible sensor formats for Golan. Furthermore, Patent Owner's calculation completely ignores any field of view adjustment to the Kawamura lens when combining Golan and Kawamura.

30. A POSITA would have expected that scaling down the Kawamura

lens to be successful for use in Golan. Lens scaling was a well-known practice in lens design, and readily performed in a lens design program. Further, a POSITA would have scaled the Kawamura lens prescriptions to fit into a digital camera of Golan while maintaining the compactness and an excellent image-formation performance. As shown with examples in Table 1 below, a POSITA would have understood that sensors of various formats may be used in the combination of Golan and Kawamura based on the application, would have applied the appropriate scaling factor based on the image sensor format (e.g., scaling factors less than 10 for image sensors of 1/3" or greater), and would have found that modifications of Kawamura's lens for the combination is practical. Further, a POSTA would have found it practical, and indeed, would have modified the field of view of Kawamura's lens for a tele field of view that's appropriate for a particular application (e.g., conventional digital still cameras, air-born vehicles/drones applications, etc.), including the example Narrow_FOV described in Golan.

Sensor Inch Format	Sensor Diagonal d (mm)	Focal Length f (mm) $d/2/\tan(\theta/2)$	Kawamura Scaling Factor s =200/f	Estimate Weight After Scaling (grams)
1/3	6	31.18	6.4	0.56
1/2.5	7.19	37.36	5.4	0.96

1/2	8	41.57	4.8	1.33
1	15.86	82.42	2.4	10.34
APS-C	28.4	147.58	1.4	59.39
FULL (35mm x 35mm)	43.27	224.85	0.9	210.04

TABLE 1

31. It is noted that while the examples in Table 1 are based on an example full angle Narrow_FOV of 10.98° of the telephoto lens in the combination of Golan and Kawamura, a POSITA would have understood that other suitable telephoto FOV may be used in the combination. The example full angle Narrow_FOV of 10.98° is calculated based on Golan's example of a full angle Wide_FOV of 60° and a loss less electronic zoom of 6^2. ((APPL-1005), Golan, [0009]). A POSITA would have understood that in the example of [0009] of Golan, "Wide_FOV=Narrow_FOV*6" indicates tan(Wide_FOV/2) = tan(Narrow_FOV/2)*6. As such, in that example, a full angle Narrow_FOV may be calculated as follows:

$$\text{Narrow\_FOV} = 2 * \tan^{-1}(\tan(\text{Wide\_FOV}/2)/6) = 2 * \tan^{-1}(\tan(60°/2)/6)$$

$$= 2 * \tan^{-1}(0.096)$$

$$= 10.98°.$$

32. Table 1 also provides estimate weights of scaled Kawamura lenses

using glass elements, which are based on the automatic glass-fit in ZEMAX for the Kawamura Example 1. An unscaled Kawamura Example 1 has weight of 183.3 grams with fitted glasses. A POSITA would have understood that the weight of the scaled lens is less than the weight of the unscaled lens divided by the scaling factor, because when scaling, the weight reduction is greater than linear. A POSITA would have been motivated to apply the Kawamura lens, with scaling if needed, in Golan, because of such a greater than linear weight reduction.

33. As shown in Appendix.A, ZEMAX analysis, which would have been within the skills of a POSITA, confirms successful scaling of representative Kawamura Example 1 to fit into an example digital camera of Golan, e.g., using an example 1/3" image sensor and a full angle tele FOV of 10.98 degrees in the combination of Golan and Kawamura.

2. Patent Owner's list of miniature telephoto lens requirements should be rejected because they are based on mischaracterizing Golan as limited to miniature camera using miniature lenses

34. Patent Owner provides a list of miniature telephoto lens requirements for a telephoto lens in Golan (1) a scaling factor of 10x or more for Kawamura, (2) an aspheric design with plastic elements, (3) an aperture stop near the first lens element, (4) a small F-Number between 2 and 3. Response, 33-51. As discussed above at VI.A, Golan's teachings include non-miniature cameras using non-miniature lenses. Because each of these miniature lens requirements is based on

miniature camera using miniature lenses, and therefore should be rejected.

42. However, to the extent that scaling by a large factor and/or miniature lenses are required in the combination of Golan and Kawamura, as shown in the analysis using lens design software ZEMAX in Appendix.B, modifications or adjustments would have been within the level of a POSITA to accommodate the teachings of Kawamura in the system of Golan. Because these modifications or adjustments were within the skill of a POSITA, they would not have dissuaded a POSITA from making the combination.

43. In the example of Appendix.B, Kawamura Example 1 is scaled to fit a 1/3" sensor with a full angle FOV of 24.6 using the steps below. At each step described below, the lens is reoptimized, and lens element thickness is adjusted if necessary to avoid negative thickness at the lens edge.

44. Step 1: The Kawamura lens data is entered into ZEMAX and optimized for minimum wavefront error, using as variables the radii of curvature but maintaining the same element focal length to keep the lens structure taught by Kawamura. Distortion aberration is controlled to be the same as in the original lens.

45. Step 2: Using standard plastic material, E48R and OKP4, the model glasses in Kawamura are substituted.

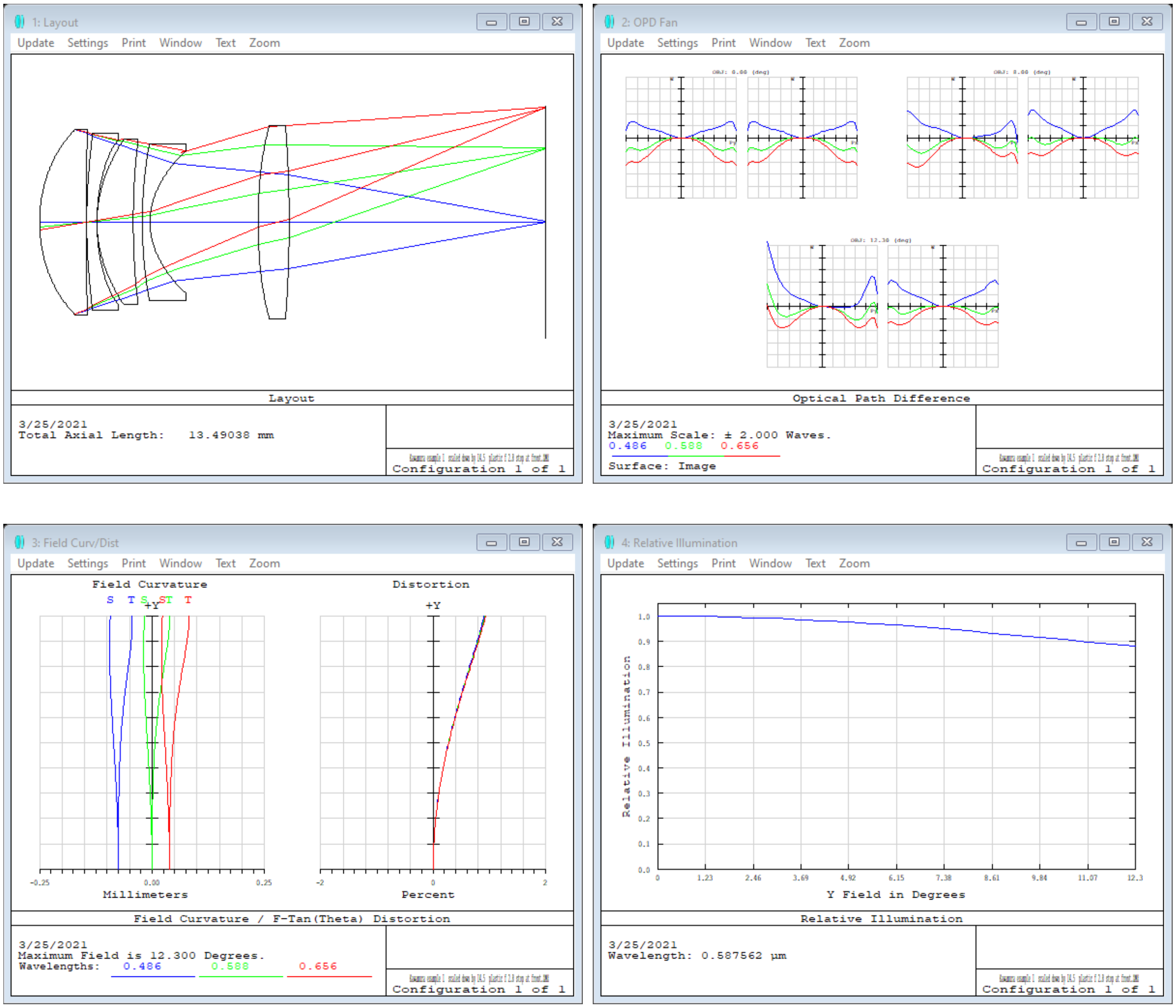
46. Step 3: The aperture stop is moved to the second lens but allowing the

surfaces to be aspheric surface as conics.

47. Step 4: The aperture stop diameter is increased to a F# of 2.8 so that the lens may cast brighter images.

48. Step 5: The lens is scaled by a factor of 14.5 for a 1/3" sensor with a diagonal of 6 mm. The field of view is the same as in the original lens +/- 12.3 degrees.

49. These steps are basic knowledge that a POSITA would have. For example, Mr. Rob Bates, who was my student, wrote a technical paper, titled "The modern miniature camera objective: an evolutionary design path from the landscape lens," which illustrates the level of skill of a POSITA at the time of the asserted patent and explains steps for designing a miniature camera from a conventional lens design. (APPL-1023), Bates. *See also* (APPL-1009), ZEMAX User's Manual (describing performing modifications of various lens parameters using ZEMAX, e.g., optimization at pages 231 and 471, model glasses at pages 263 and 587, glass catalogue at pages 203 and 204, F number at page 56, thickness at page 74, surface stop at page 75, scaling at pages 254-355, and aspheric surfaces/conics at page 317).


1: Layout
Update Settings Print Window Text Zoom
Layout
3/25/2021
Total Axial Length: 13.49038 mm
Configuration 1 of 1
2: OPD Fan
Optical Path Difference
3/25/2021
Maximum Scale: ± 2.000 Waves.
0.486 0.588 0.656
Surface: Image
Configuration 1 of 1
3: Field Curv/Dist
Field Curvature
Distortion
+Y
Millimeters
Percent
Field Curvature / F-Tan(Theta) Distortion
3/25/2021
Maximum Field is 12.300 Degrees.
Wavelengths: 0.486 0.588 0.656
Configuration 1 of 1
4: Relative Illumination
Relative Illumination
Y Field in Degrees
Relative Illumination
3/25/2021
Wavelength: 0.587562 µm
Configuration 1 of 1

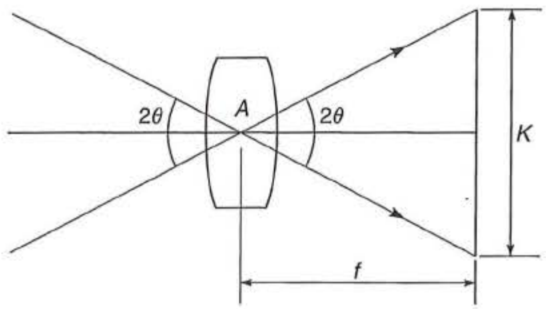


Figure 4.13 Field (angle) of view (FOV) of a lens related to format dimension

distances to real objects and real images are considered to be positive. All distances to virtual images are considered as negative. The magnification of a virtual image is also negative. An alternative Cartesian convention takes the lens or refracting surface at the origin so distances measured to the right are positive, and distances to the left are negative.

It is useful to note that when the object conjugate u is very large, as for a distant subject, the corresponding value of the image conjugate v may be taken as f, the focal length. Consequently, the magnification is given by $m = f/u$. Thus, image magnification or scale depends directly on the focal length of the camera lens for a subject at a fixed distance. From a fixed viewpoint, to maintain a constant image size as subject distance varies a lens with variable focal length is required, i.e. a zoom lens (see Chapter 7).

Field angle of view

The focal length of a lens also determines the angle of the *field of view* (FOV) relative to a given film or sensor format. The FOV is defined as the angle subtended at the (distortion-free) lens by the diagonal (K) of the format when the lens is focused on infinity (Figure 4.13).

Given that the FOV angle A is twice the semi-angle of view θ, then:

$$A = 2\theta = 2\tan^{-1}\left(\frac{K}{2f}\right) \qquad (12)$$

The field of view for a particular combination of focal length and film format may be obtained from Table 4.1. To use this table, the diagonal of the negative should be divided by the focal length of the lens; the FOV can then be read off against the quotient obtained.

Table 4.1 Table for deriving field of view of an orthoscopic lens

Diagonal/focal length (K/f)	*Field of view* (2θ) degrees*
0.35	20
0.44	25
0.54	30
0.63	35
0.73	40
0.83	45
0.93	50
1.04	55
1.15	60
1.27	65
1.40	70
1.53	75
1.68	80
1.83	85
2.00	90
2.38	100
2.86	110
3.46	120

*These values are for a lens which produces geometrically correct perspective.

As the lens to subject distance decreases, the lens to film distance increases, and the FOV decreases from its infinity-focus value. At unit magnification the FOV has approximately half its value at infinity focus.

Photographic lenses can be classified according by FOV for the particular film format for which they are designed. There are sound reasons for taking as 'standard' a lens that has a field of view approximately equal to the diagonal of the film format. For most formats this angle will be around 52 degrees. Wide-angle lenses can have FOVs up to 120 degrees or more, and long focus lenses down to 1 degree or less. Table 4.2 gives a classification of lenses for various formats based on FOV.

Occasionally confusion may arise as to the value of the FOV of a lens as quoted, because a convention exists in many textbooks on optics to quote the semi-angle θ, in which cases value given must be doubled for photographic purposes. It should also be noted that the FOV for the *sides* of a rectangular film format is always less than the value quoted for the diagonal. The horizontal FOV is perhaps the most useful value to quote.

The term 'field of view' becomes ambiguous when describing lenses that produce distortion, such as fish-eye and anamorphic objectives. In such cases it may be preferable to describe the angle subtended by the diagonal of the format at the lens as the 'angle of the field' and the corresponding angle in the object space as the 'angle of view'.

US 20080030592A1

(19) United States
(12) Patent Application Publication
Border et al.

(10) Pub. No.: US 2008/0030592 A1
(43) Pub. Date: Feb. 7, 2008

(54) PRODUCING DIGITAL IMAGE WITH DIFFERENT RESOLUTION PORTIONS

(75) Inventors: **John N. Border**, Walworth, NY (US); **Scott C. Cahall**, Fairport, NY (US); **John D. Griffith**, Rochester, NY (US)

Correspondence Address:
EASTMAN KODAK COMPANY
PATENT LEGAL STAFF
343 STATE STREET
ROCHESTER, NY 14650-2201

(73) Assignee: **Eastman Kodak Company**

(21) Appl. No.: **11/461,574**

(22) Filed: **Aug. 1, 2006**

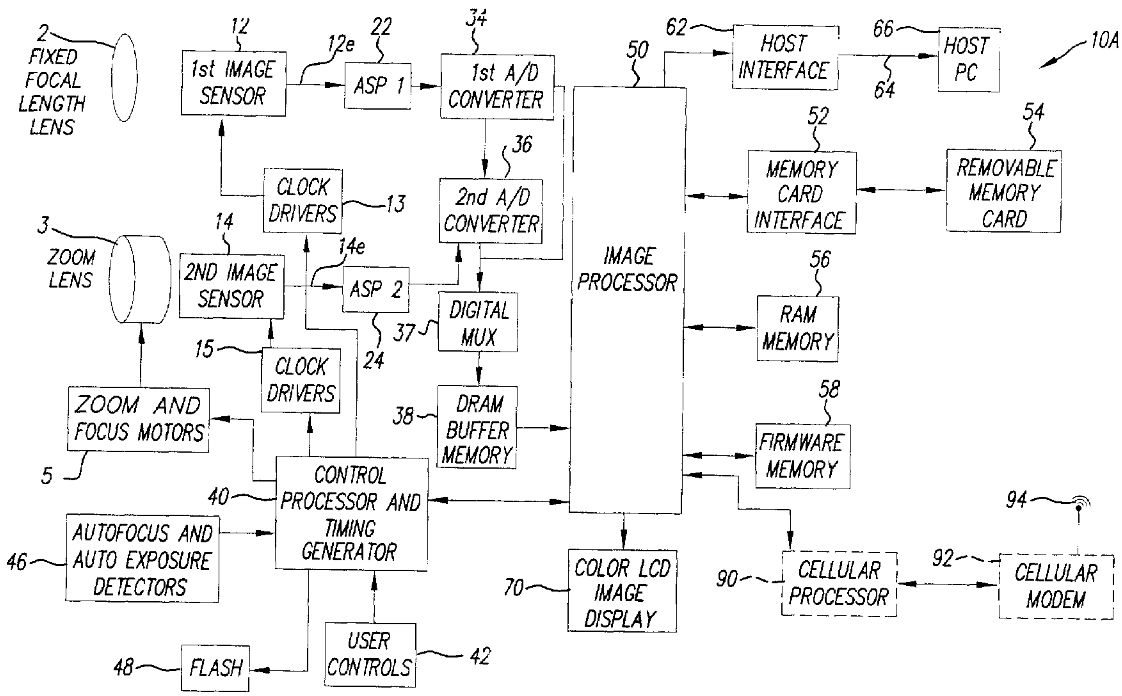
Publication Classification

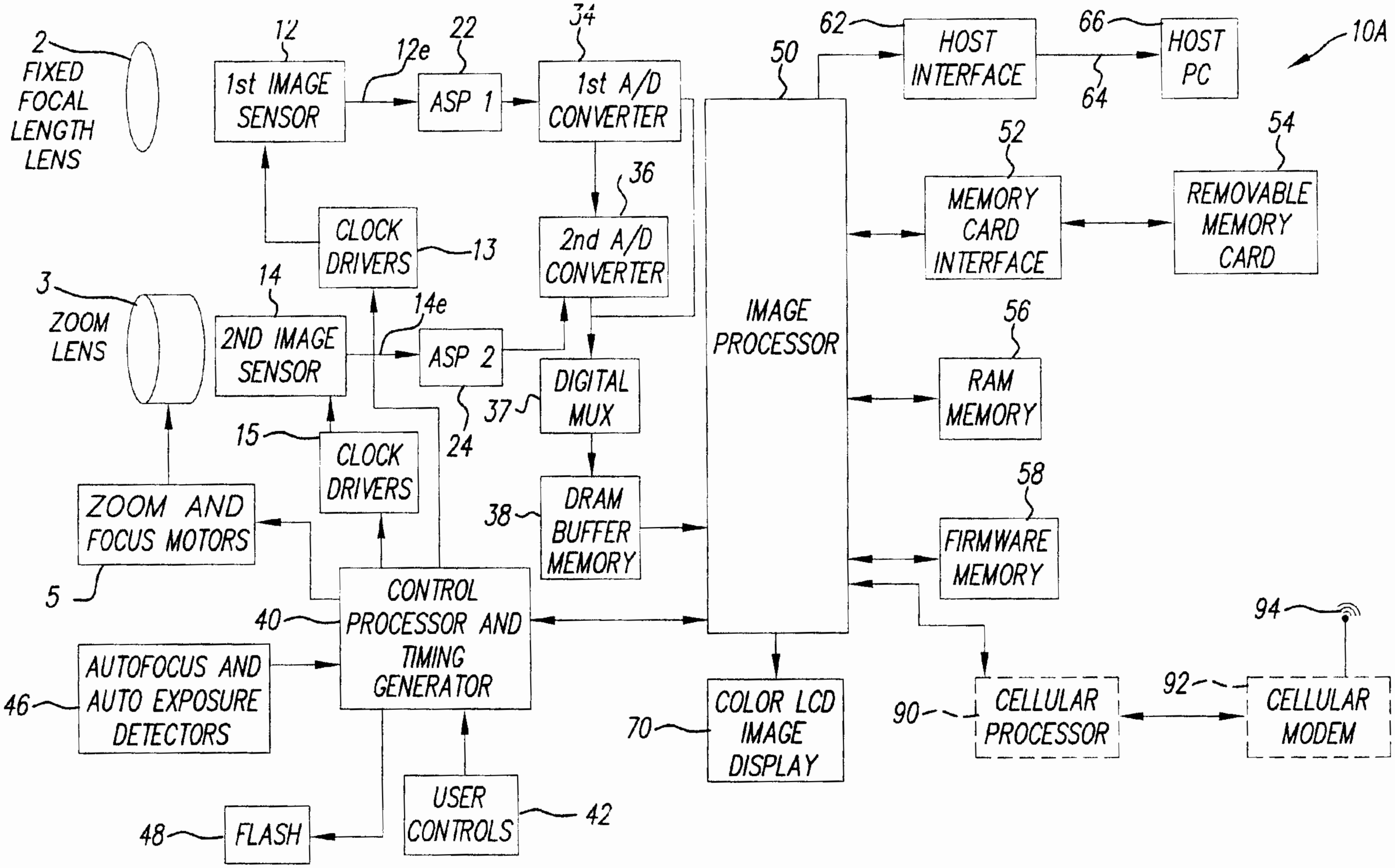
(51) Int. Cl.
G06T 5/50 (2006.01)

(52) U.S. Cl. **348/218.1**; 348/E05.028

(57) **ABSTRACT**

A method of producing a digital image with improved resolution during digital zooming, including simultaneously capturing a first low resolution digital image of a scene and a second higher resolution digital image of a portion of substantially the same scene. A composite image is then formed by combining the first low-resolution digital image and a corresponding portion of the high resolution digital image. Digital zooming of the composite image produces a zoomed image with high resolution throughout the zoom range and improved image quality.





2
FIXED FOCAL LENGTH LENS
12
1st IMAGE SENSOR
12e
22
ASP 1
34
1st A/D CONVERTER
36
2nd A/D CONVERTER
50
IMAGE PROCESSOR
62
HOST INTERFACE
64
66
HOST PC
10A
52
MEMORY CARD INTERFACE
54
REMOVABLE MEMORY CARD
CLOCK DRIVERS
13
3
ZOOM LENS
14
2ND IMAGE SENSOR
14e
ASP 2
24
37
DIGITAL MUX
56
RAM MEMORY
15
CLOCK DRIVERS
ZOOM AND FOCUS MOTORS
5
38
DRAM BUFFER MEMORY
58
FIRMWARE MEMORY
40
CONTROL PROCESSOR AND TIMING GENERATOR
94
46
AUTOFOCUS AND AUTO EXPOSURE DETECTORS
70
COLOR LCD IMAGE DISPLAY
90
CELLULAR PROCESSOR
92
CELLULAR MODEM
48
FLASH
USER CONTROLS
42

FIG. 1A

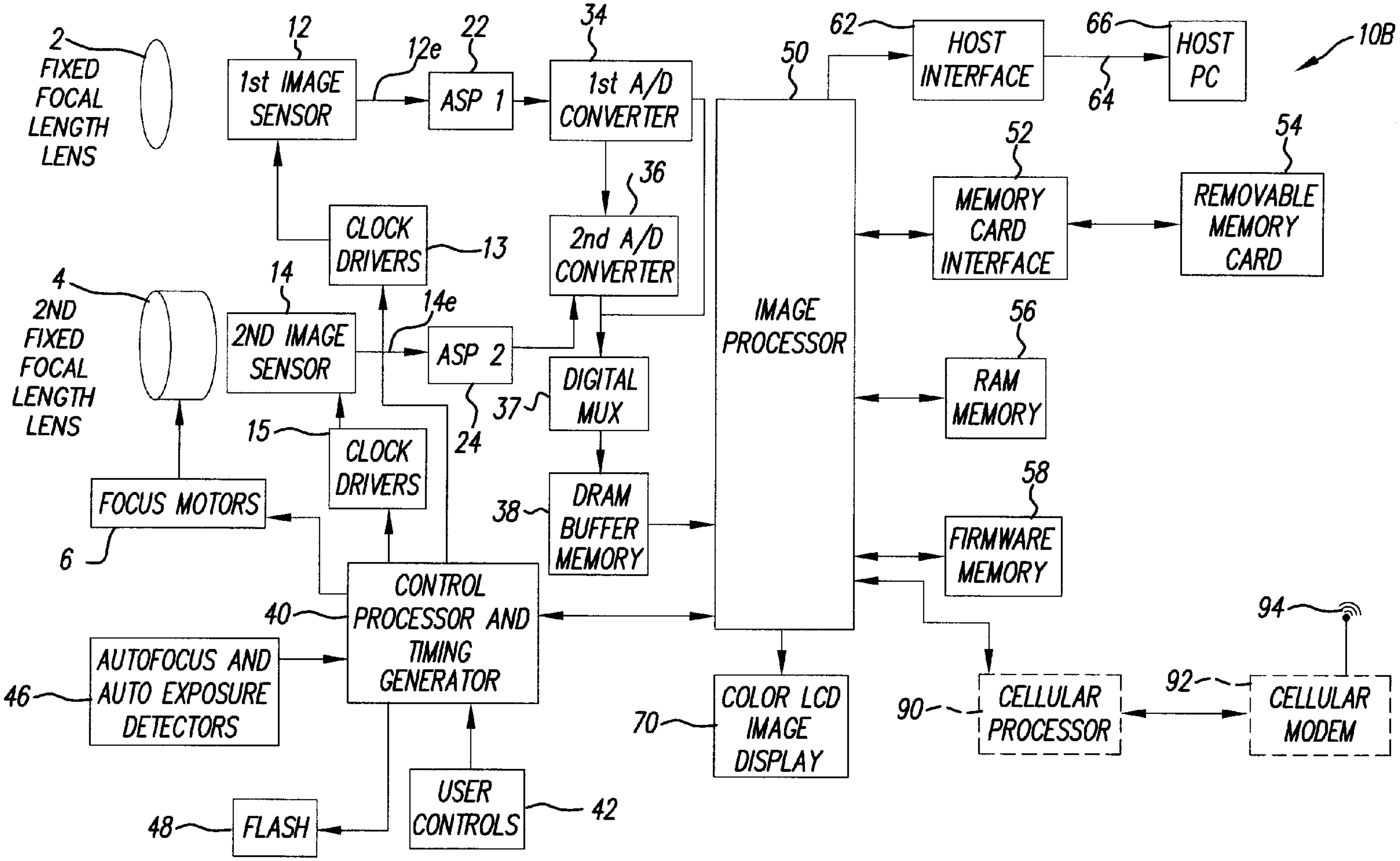

10B
2
FIXED FOCAL LENGTH LENS
4
2ND FIXED FOCAL LENGTH LENS
6
FOCUS MOTORS
12
1st IMAGE SENSOR
12e
14
2ND IMAGE SENSOR
14e
13
CLOCK DRIVERS
15
CLOCK DRIVERS
22
ASP 1
24
ASP 2
34
1st A/D CONVERTER
36
2nd A/D CONVERTER
37
DIGITAL MUX
38
DRAM BUFFER MEMORY
40
CONTROL PROCESSOR AND TIMING GENERATOR
42
USER CONTROLS
46
AUTOFOCUS AND AUTO EXPOSURE DETECTORS
48
FLASH
50
IMAGE PROCESSOR
52
MEMORY CARD INTERFACE
54
REMOVABLE MEMORY CARD
56
RAM MEMORY
58
FIRMWARE MEMORY
62
HOST INTERFACE
64
66
HOST PC
70
COLOR LCD IMAGE DISPLAY
90
CELLULAR PROCESSOR
92
CELLULAR MODEM
94

FIG. 1B

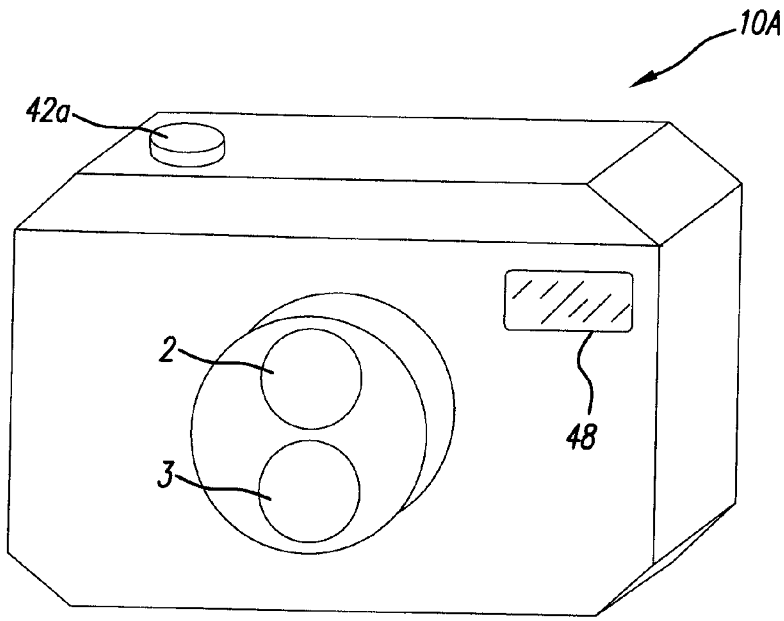


FIG. 2A

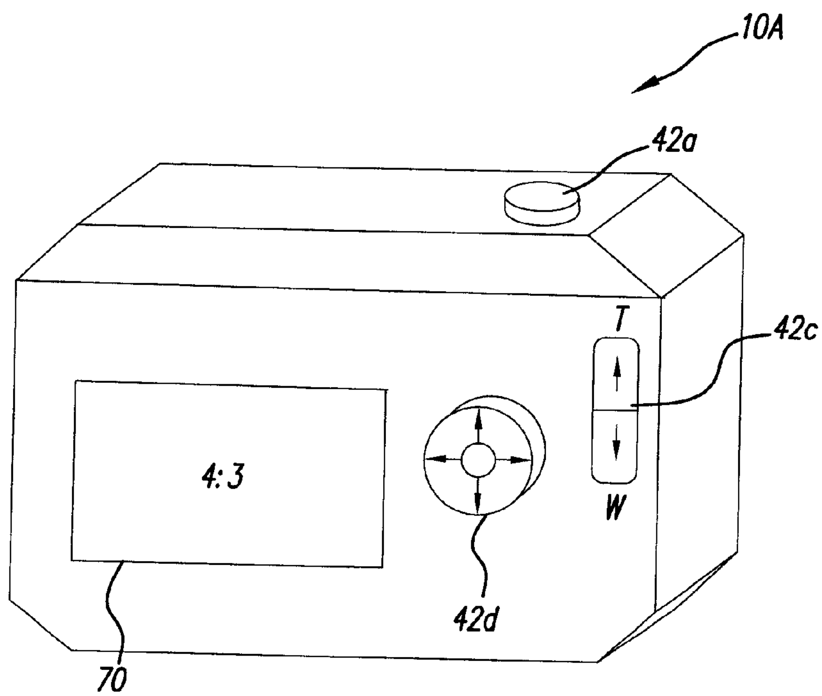


FIG. 2B

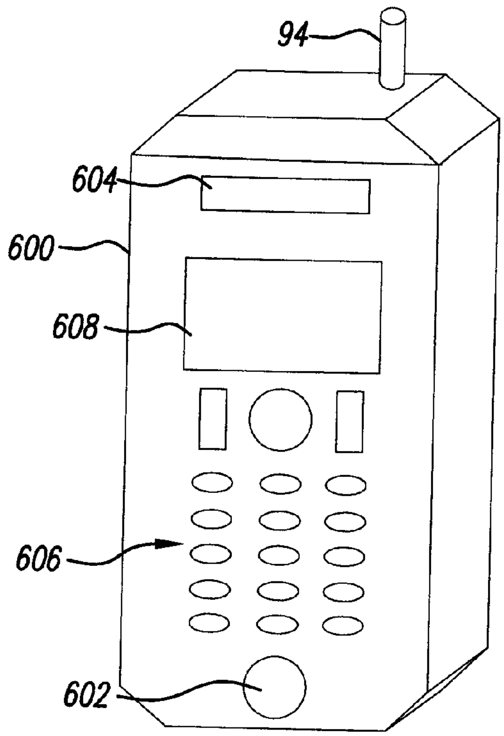

94
604
600
608
606
602

FIG. 3A

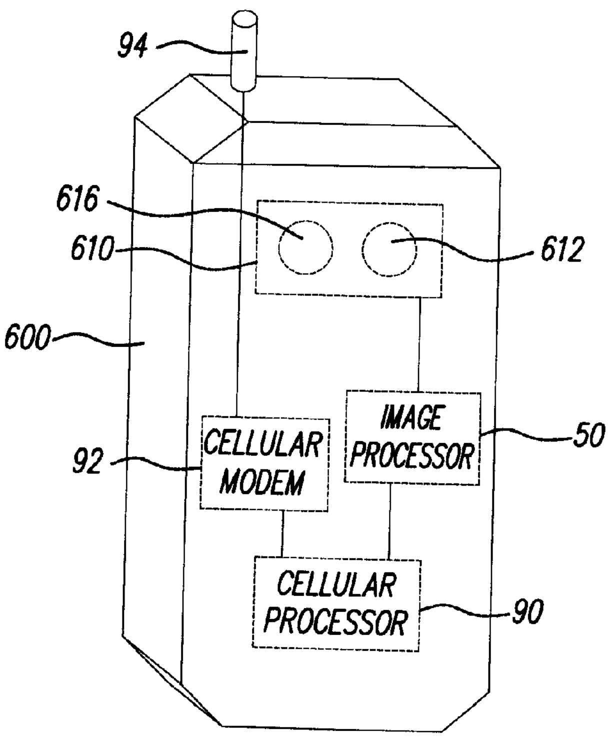

94
616
610
612
600
IMAGE PROCESSOR
50
CELLULAR MODEM
92
CELLULAR PROCESSOR
90

FIG. 3B

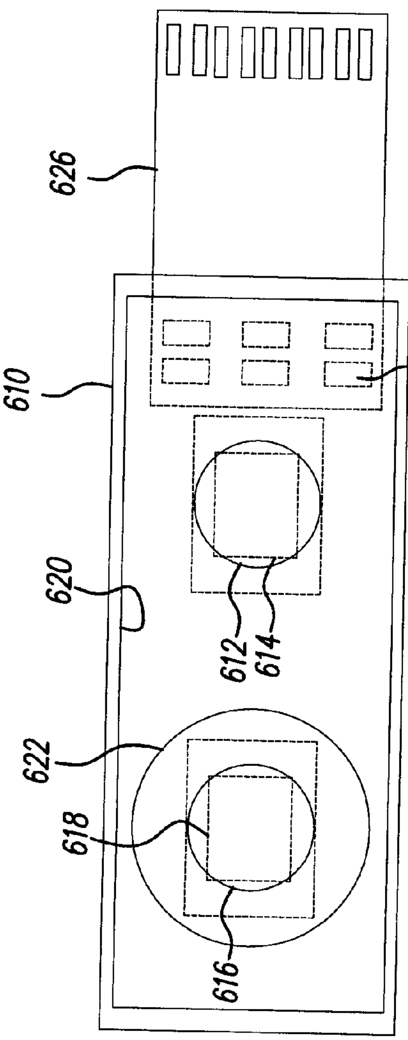

626
610
624
620
612
614
622
618
616

FIG. 4A

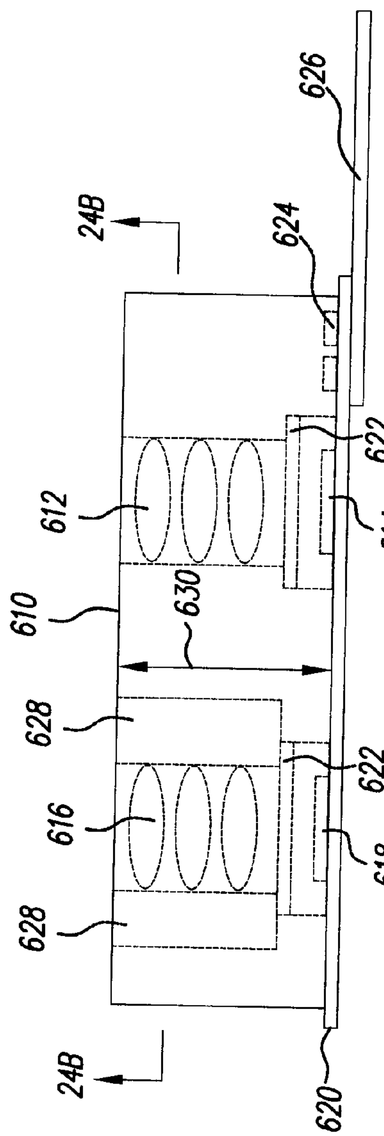

24B
626
624
622
612
614
610
630
628
616
622
618
628
24B
620

FIG. 4B

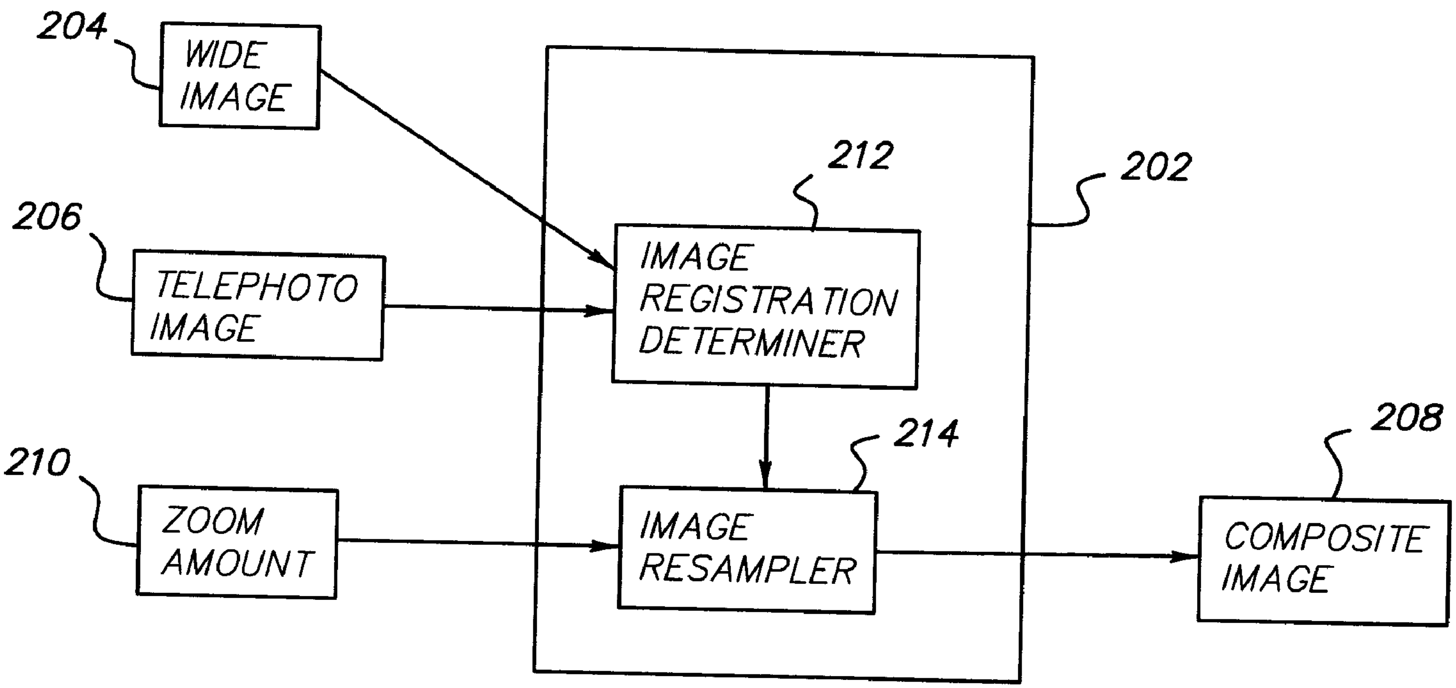

204
WIDE IMAGE
206
TELEPHOTO IMAGE
210
ZOOM AMOUNT
212
IMAGE REGISTRATION DETERMINER
202
214
IMAGE RESAMPLER
208
COMPOSITE IMAGE

FIG. 5

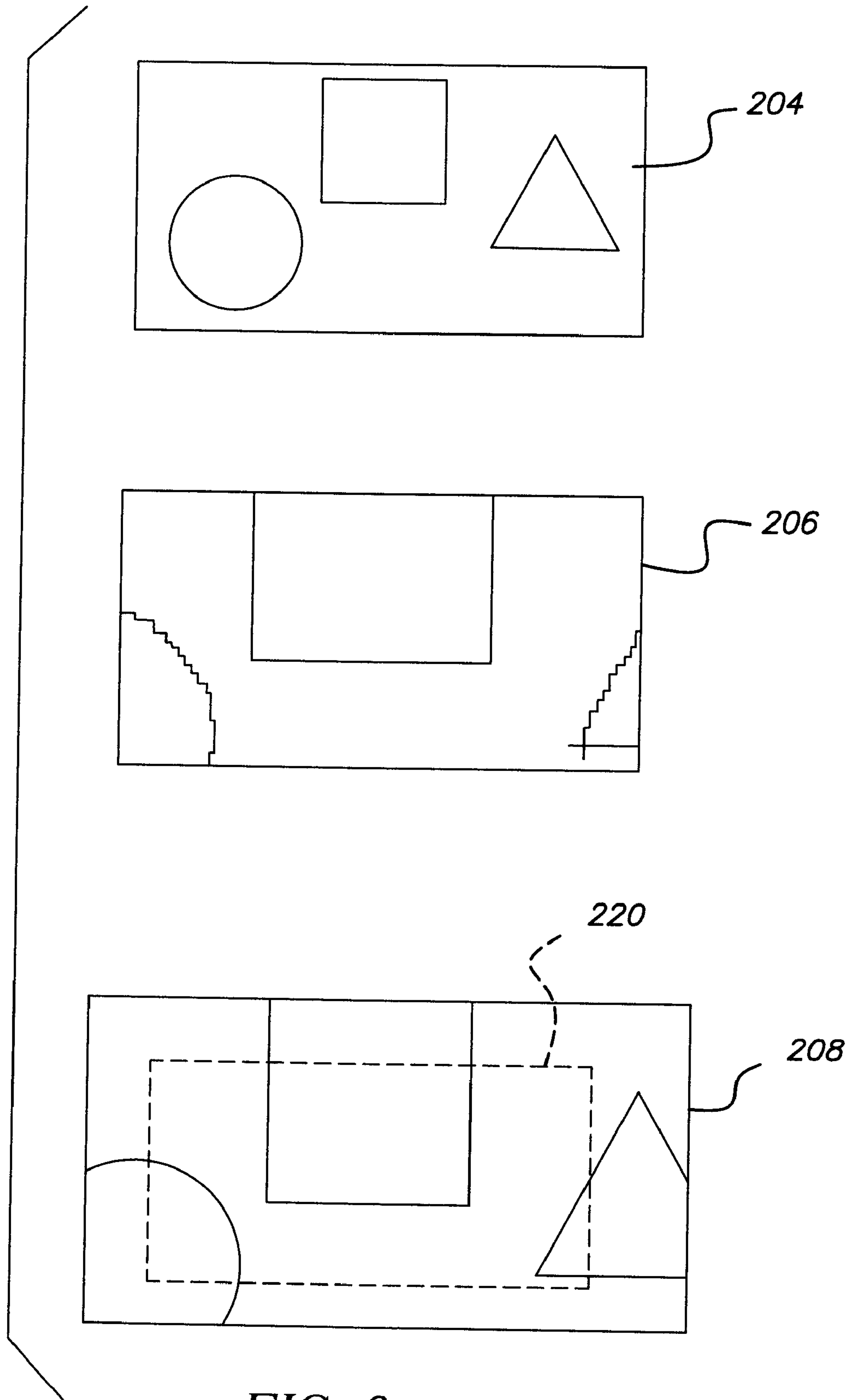


FIG. 6

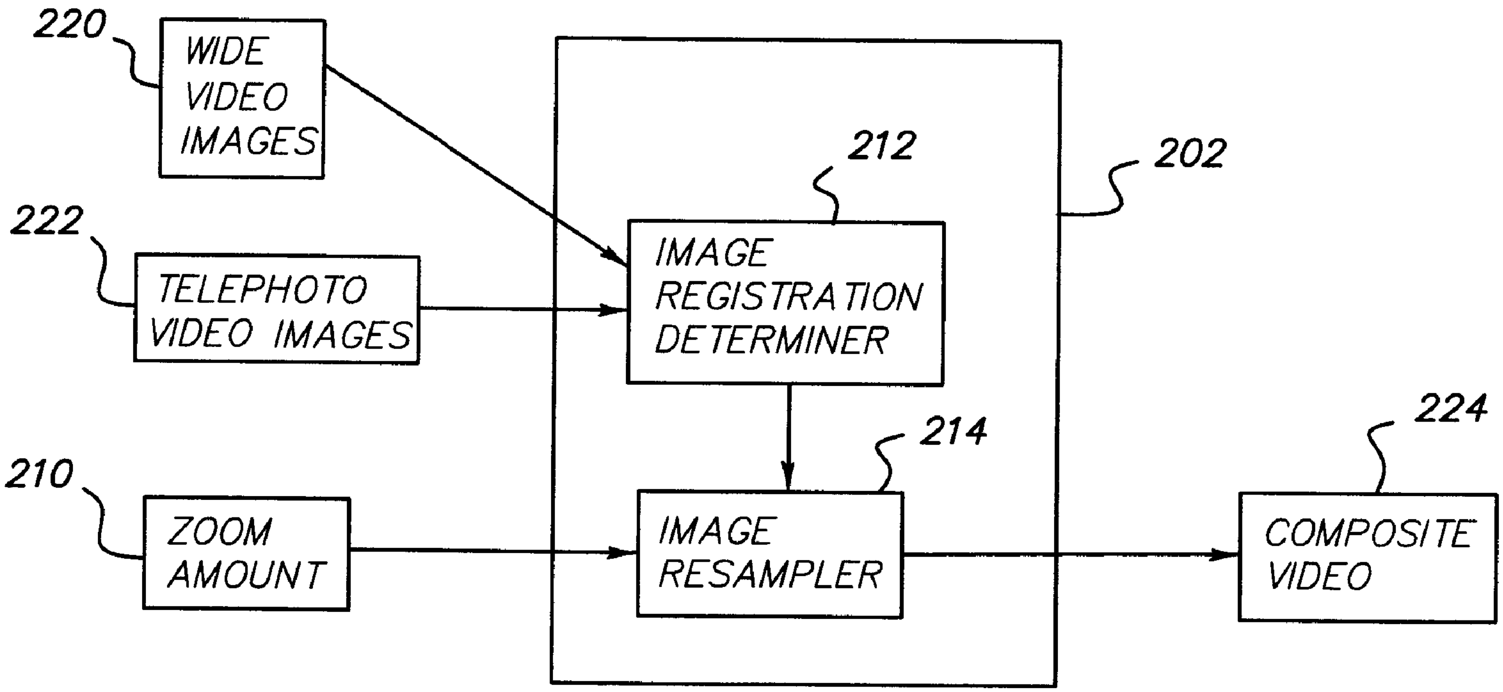

220
WIDE VIDEO IMAGES
222
TELEPHOTO VIDEO IMAGES
210
ZOOM AMOUNT
212
IMAGE REGISTRATION DETERMINER
214
IMAGE RESAMPLER
202
224
COMPOSITE VIDEO

FIG. 7

PRODUCING DIGITAL IMAGE WITH DIFFERENT RESOLUTION PORTIONS

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] Reference is made to commonly assigned U.S. Patent Application Serial No. 2002/0075258, filed Nov. 23, 2001, entitled "Camera System with High Resolution Image Inside a Wide Angle View" by Park et al. and U.S. patent application Ser. No. 11/062,174, filed Feb. 18, 2005, entitled "Digital Camera Using Multiple Lenses And Image Sensors To Provide An Extended Zoom Range" by Peter Labaziewicz, et al., the disclosures of which are incorporated herein.

FIELD OF THE INVENTION

[0002] The present invention relates to a digital camera that uses multiple lenses and image sensors to provide an extended zoom range and the method used to produce a digital image that combines the multiple images produced by the digital camera.

BACKGROUND OF THE INVENTION

[0003] Currently, most digital cameras use a zoom lens and a single color image sensor to capture still and motion images. The captured images are then digitally processed to produce digital image files, which are stored in a digital memory in the camera. The digital image files can then be transferred to a computer, displayed, and shared via the Internet. The digital camera can be included as part of a mobile telephone, to form a so-called "camera phone." The camera phone can transmit the digital image files to another camera phone, or to service providers, via a mobile telephone network.

[0004] Small camera size and a large zoom range are two very important features of digital cameras. Users prefer to have a large zoom range (e.g. 5:1 or greater) rather than a limited zoom range (e.g. 3:1 or smaller). The zoom range is typically composed of both optical zoom which is provided by variable focal length lenses and digital zoom which is provided by a magnification of the digital image after capture. Variable focal length lenses for large zoom range are expensive and they increase the size of the digital camera. Thus, there are trade-off's between small camera size, large zoom range, and low camera cost which must be made when designing a digital camera. With higher cost cameras, such as single lens reflex cameras, these problems are sometimes addressed by using multiple interchangeable zoom lenses, such as two 3:1 zoom lenses, e.g., a 28-70 mm zoom and a 70-210 zoom. This arrangement has user inconvenience problems and is presently not available for low cost digital cameras.

[0005] A different solution that has been offered by Kodak in the V570 and the V610 cameras is to include two different lens assemblies in the camera with two different focal lengths and two separate image sensors. In this case, each of the lens assemblies can be either a fixed focal length lens or can have a moderate optical zoom range to reduce the size and cost of each of the lens assemblies. Together, the two lens assemblies provide a wide zoom range and a small overall size at a lower cost. However, a problem arises when the focal length of the first lens does not match the focal length of the second lens so that the optical zoom is not continuous over the entire zoom range. In this case, digital zoom must be used for zoom between the maximum zoom of the first lens and the minimum zoom of the second lens.

[0006] Digital zoom based on increased magnification of the image with a corresponding decrease in resolution is well known in the art. Although digital zoom is very fast and simple, the decrease in resolution can produce a perceived decrease in image quality.

[0007] In U.S. Pat. No. 5,657,402, a method is described in which a plurality of digital images are combined to form an image. U.S. Pat. No. 5,657,402 addresses the use of multiple images captured at different times wherein "the plurality of images of various focal lengths, such as a zoom video sequence" (col. 1, lines, 21-22) are captured from the same lens. U.S. Pat. No. 5,657,402 does not address two lens assemblies simultaneously capturing images of the same scene.

[0008] In US Publication No. 2002/0075258, a panoramic camera system is described in which a moveable telephoto camera is additionally used to capture a high-resolution portion of the scene which is then overlaid onto the panoramic image. US Publication No. 2002/0075258 describes the use of a moveable telephoto camera to enable a higher resolution of a portion of the image wherein the moveable telephoto camera can be moved to the region of the panoramic image where the higher resolution is desired. US Publication No. 2002/0075258 does not address the case wherein a wide-angle camera and a telephoto camera are affixed together for simultaneous capture of the same scene. In addition, US Publication No. 2002/0075258 does not disclose the use of a composite image for improved image quality in a digital zoom system.

SUMMARY OF THE INVENTION

[0009] The present invention provides a sufficiently compact, low cost, optical system with a large zoom range for a small, lightweight and relatively inexpensive consumer digital camera.

[0010] What is therefore needed is a digital camera that provides a rapidly-operating extended zoom range without unduly increasing the size or cost of the digital camera while providing good perceived image quality throughout the zoom range.

[0011] An object of the invention is to provide a method of producing a digital image having portions with different resolutions comprising:

[0012] a. simultaneously capturing first and second digital images of the same scene wherein the first digital image is of a larger portion of the scene than the second digital image wherein the second digital image has a higher resolution than the resolution in the first digital image corresponding to the second digital image; and

[0013] b. combining at least a portion of the second digital image into the corresponding portion of the first digital image to thereby provide a digital image having portions with different resolutions.

[0014] The present invention is directed to overcoming the problems set forth above. Briefly summarized, the invention includes an electronic camera for producing an image of a scene, wherein the camera includes a first image sensor for generating a first sensor output, a first lens with a first focal length for forming a first image of the scene on the first image sensor, a second image sensor for generating a second sensor output, and a second lens with a second focal length

that is longer than the focal length of the first lens for forming a second image of the same scene on the second image sensor. The first lens or the second lens can be either fixed focal length lenses or multiple focal length lenses as in a zoom lens wherein, the first and second lenses are directed at substantially the same scene and image sets are captured substantially simultaneously by the first image sensor and the second image sensor. Portions of the image set captured by the first image sensor and the second image sensor are then combined to produce a composite image with a higher resolution in the portion of the composite image that is provided by the second image sensor due to the longer focal length of the second lens. Subsequent images produced during a digital zooming process are composed largely of the lower resolution image captured by the first image sensor at low digital zoom values and largely of the higher resolution image as captured by the second image sensor at high digital zoom values.

[0015] By forming a composite image with portions of the image from the short focal length lens and portions of the image from the longer focal length lens, perceived image quality is improved throughout the zoom range while lens complexity is reduced, since a continuous zoom ratio can be produced with unmatched lens focal lengths. By capturing images from the two image sensors substantially simultaneously, complexities in the image processing are reduced since differences between the two images due to motion of the camera or motion within the scene are avoided. It is an additional advantage, that the present invention can avoid the slow response that is typical of an optical zoom system when traversing a large zoom range.

[0016] These and other aspects, objects, features and advantages of the present invention will be more clearly understood and appreciated from a review of the following detailed description of the preferred embodiments and appended claims, and by reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] FIGS. **1**A and **1**B depict a block diagram of a digital camera using a fixed focal length wide-angle lens with a first image sensor and a zoom lens, or a longer second fixed focal length lens, with a second image sensor according to the present invention;

[0018] FIGS. **2**A and **2**B show front and rear perspective views of the digital camera;

[0019] FIGS. **3**A and **3**B are perspective views of the front and back of a cell phone including a camera with multiple lenses and multiple sensors according to the present invention;

[0020] FIGS. **4**A and **4**B show two views of the capture assembly used in the cell phone shown in FIGS. **3**A and **3**B

[0021] FIG. **5** is a block diagram of the stitching process to create the composite image;

[0022] FIG. **6** depicts a wide angle image as captured, a telephoto image as captured, and a composite image as created by the invention; and

[0023] FIG. **7** is a block diagram of the stitching process with video images to create a composite video.

DETAILED DESCRIPTION OF THE INVENTION

[0024] Because digital cameras employing imaging devices and related circuitry for signal capture, correction, and exposure control are well known, the present description will be directed in particular to elements forming part of, or cooperating more directly with, method and apparatus in accordance with the present invention. Elements not specifically shown or described herein are selected from those known in the art. Certain aspects of the embodiments to be described are provided in software. Given the system as shown and described according to the invention in the following materials, software not specifically shown, described or suggested herein that is useful for implementation of the invention is conventional and within the ordinary skill in such arts.

[0025] In the image capture device that is the subject of the invention, two or more lens systems are associated with a respective number of image sensors. The lenses have different focal lengths and different fields of view within the same scene wherein the field of view of the longer focal length lenses contains at least a portion of the field of view of the shorter focal length lens. In addition, the image captured by the image sensor associated with the longer focal length lens has a higher resolution than the image captured by the image sensor associated with the lens with the shorter focal length.

[0026] In the embodiment of the invention, the image capture done by the two or more image sensors is done substantially simultaneously so that motion artifacts from motion of the camera or motion within the scene, do not cause differences in the two or more images that are captured. The invention discloses the use of the two or more images to form a composite image that includes portions of each of the two or more images for the purpose of providing a digitally zoomed image with uniformly high resolution.

[0027] Each of the several embodiments of the present invention include an image capture assembly having multiple lenses and multiple image sensors mounted within a digital camera wherein the multiple lenses have different focal lengths and portions of the fields of view are substantially the same and the multiple image sensors can capture images simultaneously. The invention describes an arrangement for producing an image that is formed by combining the images from the multiple image sensors in a way that provides increased resolution in a digitally zoomed image.

[0028] In each embodiment, the camera captures images from the multiple image sensors simultaneously. Each multiple lens system contains at least one fixed focal length lens or variable focal length lens as in an optical zoom lens. Moreover, each embodiment includes some type of user control that allows a user to select a zoom amount, which controls both the digital zoom and the optical zoom lens if present. In some embodiments, a single "zoom lens" user control is used. e.g., where the "wide" setting selects a wide angle fixed focal length lens and the "tele" setting(s) select various positions of a zoom lens. In any case, digital zooming is used along with any optical zoom that is present to provide a continuous zoom "up" from the image obtained with the short focal length lens to the maximum focal length of the multiple lenses. All this, of course, can be transparent

to the user, who simply manipulates the "zoom" user control between the "wide" and "tele" settings.

[0029] The composite image can be formed during image processing on the camera or later during post processing when the images have been offloaded from the camera. In either case, the two images must be matched to locate the high-resolution image accurately into the low-resolution image and then stitched into place so the edge between the two images in the composite image is not discernible. To enable the composite image to be formed during post processing, both images in the image set must be stored at the time of image capture. In the case of video, by storing the low-resolution video and the high resolution video, the zoom ratio can be selected after image capture and adjusted as desired at that time.

[0030] Turning now to FIG. **1**A, a digital camera **10**A is described which includes an image capture assembly, including a fixed focal length lens **2** that focuses an image of a scene (not shown) onto a first image sensor **12**, and a zoom lens **3** which focuses an image of the scene onto a second image sensor **14**. The image capture assembly **1** provides a first image output signal **12***e* from the first image sensor **12** and a second image output signal **14***e* from the second image sensor **14**.

[0031] The focal length of the fixed focal length lens **2** generates a wide-angle field of view and has a fixed focus set to a distance near the lens hyperfocal distance of 8 feet so that objects from 4 feet to infinity are in focus. Therefore, the fixed focal length lens **2** does not need to include a focus adjustment. The fixed focal length lens **2** includes an adjustable aperture and shutter assembly to control the exposure of the first image sensor **12**. The zoom lens **3** includes an optical zoom and autofocus controlled by zoom and focus motors **5** and an adjustable aperture and shutter assembly to control the exposure of the image sensor.

[0032] In a preferred embodiment, the image sensors **12** and **14** are single-chip color Megapixel CCD sensors, using the well-known Bayer color filter pattern to capture color images. The image sensors **12** and **14** can have, for example, a 4:3 image aspect ratio and a total of 3.1 effective megapixels (million pixels), with 2048 active columns of pixels×1536 active rows of pixels. The image sensors **12** and **14** can use a ½" type optical format, so that each pixel is approximately 3.1 microns tall by 3.1 microns wide. A control processor and timing generator **40** controls the first image sensor **12** by supplying signals to clock drivers **13**, and controls the second image sensor **14** by supplying signals to clock drivers **15**.

[0033] The control processor and timing generator **40** also controls the zoom and focus motors **5** for zoom lens **3**, and a flash **48** for emitting light to illuminate the scene. The control processor and timing generator **40** also receives signals from automatic focus and automatic exposure detectors **46**. In an alternative embodiment, instead of using the automatic focus and automatic exposure detectors **46**, the image sensor **14** could be used to provide exposure detection and "through-the-lens" autofocus, as described in commonly-assigned U.S. Pat. No. 5,668.597 entitled "Electronic Camera with Rapid Automatic Focus of an Image upon a Progressive Scan Image Sensor" which issued Sep. 26, 1997 in the names of Kenneth A. Parulski, Masaki Izumi, Seiichi Mizukoshi and Nobuyuki Mori, incorporated herein by reference. User controls **42** are used to control the operation of the digital camera **10**A.

[0034] The first image output signal **12***e* from the first image sensor **12** is amplified by a first analog signal processor (ASP **1**) **22** and provided to a first analog-to-digital (A/D) converter **34**. The second image output signal **14***e* from the second image sensor **14** is amplified by a second analog signal processor (ASP **2**) **24** and provided to a second A/D converter **36**.

[0035] The digital data from the A/D converters **34** and **36** is provided to digital multiplexer **37**. The digital multiplexer **37** is used to select which one of the outputs of the two A/D converters **34** and **36** is connected to the DRAM buffer memory **38**. The digital data is stored in DRAM buffer memory **38** and subsequently processed by an image processor **50**. The processing performed by the image processor **50** is controlled by firmware stored in fin-ware memory **58**, which can be flash EPROM memory. The image processor **50** processes the input digital image file, which is buffered in a RAM memory **56** during the processing stage. The image processor **50** combines the digital data from the A/D converters **34** and **36** to form a composite image with areas of high resolution and areas of lower resolution using a method, which constitutes the invention.

[0036] As shown in FIG. **5**, the image processor **50** of FIGS. **1**A and **1**B contains an image compositor **202** that receives both the wide image **204** from the fixed focal length lens **2** and the telephoto image **206** from the zoom lens **3**. The telephoto image **206** is of a smaller portion of the scene than the wide image **204**, but captures this smaller portion with greater resolution than the resolution of the wide image **204**. The image compositor **202** generates a composite image **208** using image data from both the wide image **204** and the telephoto image **206**. Also, the image compositor **202** receives a zoom amount **210** that can be adjusted by the camera user as will be described below.

[0037] It is desirable for the image compositor **202** to generate a composite image **208** that has the highest possible quality. For illustration, assume that the wide image **204** and the telephoto image **206** have the same number of rows R and columns C of pixels, for example, R=1000 and C=1500 and that the relative magnification ratio M of the telephoto image **206** to the wide image **204** is M=3.

[0038] The image registration determiner **212** determines the registration between the wide image **204** and the telephoto image **206**. The coordinate transformation is simply a translation and a scale because the image sensors that capture the wide image **204** and the telephoto image **206** are coplanar. A convenient way to represent the registration between the images is to find the mapping of the four corner pixels of the telephoto image **206** onto the wide image **204**. For example,

Telephoto Image Coordinates	Wide Image Coordinates
(0, 0)	(333, 499.7)
(999, 0)	(666, 499.7)
(0, 1499)	(333, 999.3)
(999, 1499)	(666, 999.3)

The registration can also be stored in the form of the homography H_{TW} that transforms the coordinates of the telephoto image **206** to the wide image **204**.

[0039]

$$\begin{bmatrix} x_w \\ y_w \\ 1 \end{bmatrix} = H_{TW} \begin{bmatrix} x_T \\ y_T \\ 1 \end{bmatrix}$$

Where coordinates of the telephoto image **206** are in (row, column) notation (y_T, x_T) and coordinates of the wide image **204** are (y_W, x_W). For example,

[0040]

$$H_{TW} = \begin{bmatrix} 1/M & 0 & 499.7 \\ 0 & 1/M & 333 \\ 0 & 0 & 1 \end{bmatrix}$$

[0041] The correspondences between the coordinate systems represent the registration between the wide image **204** and the telephoto image **206**. The correspondences are preferably determined at the time of manufacture by shooting test targets, as is well known in the art. If one or both of the lenses were a zoom lens rather than a fixed lens., the registration correspondences could still be determined at the time of manufacture as a function of the zoom position of the lenses. It should be further noted that while the example shows a pure translate and scale transformation, it may be necessary to correct for a difference in tilt between the two imaging systems.

[0042] Alternatively, the registration between images can be determined using the image information contained in the wide image **204** and telephoto image **204**. This is well known in the art of image processing (for example, image registration is described in U.S. Pat. No. 6,078,701) and generally includes the steps of finding interest points in each image, making guesses at corresponding points (i.e. a scene feature that appears in both images), determining an initial guess at the registration, using that initial guess to refine the correspondence point guess, and so on based on comparing pixel values or contrast in the two images.

[0043] The image resampler **214** uses the registration information and the zoom amount **210** to produce the composite image **208**. Preferably, the composite image has the same number of rows and columns of pixels as the wide image **204** and the telephoto image **206**. However, it is well known to those skilled in the art that modifying the number of rows and columns of pixels (interpolating the image) can easily be done so that the image contains the desired number of pixels.

[0044] The zoom amount **210** Z specifies the desired relative zoom amount of the produced composite image **208**. Preferably, when the value of Z=1, then the composite image is the wide image **204**. On the other hand, when Z-M, then the composite image **208** is the telephoto image **206**. When the zoom amount is between 1 and M, data from both the wide image **204** and the telephoto image **206** are used by the image resampler **214** to produce the composite image **208**.

[0045] The image resampler **214** applies the zoom amount Z as follows: Each pixel position (y_c, x_c) of the composite image **208** is mapped to the coordinates of wide image **204** according to:

$$\begin{bmatrix} x_W \\ y_W \\ 1 \end{bmatrix} = H_{CW} \begin{bmatrix} x_C \\ y_C \\ 1 \end{bmatrix}$$

where

$$H_{CW} = \begin{bmatrix} 1/Z & 0 & (1-M)(C-1) \\ 0 & 1/Z & (1-M)(C-1) \\ 0 & 0 & 1 \end{bmatrix}$$

In a similar manner, the position (y_c, x_c) of the composite image **208** is mapped to the coordinates of the telephoto image **206** using the equation:

$$\begin{bmatrix} x_T \\ y_T \\ 1 \end{bmatrix} = (H_{TW})^{-1} H_{CW} \begin{bmatrix} x_C \\ y_C \\ 1 \end{bmatrix}$$

Then, the pixel value of the composite image at position (y_c, x_c) is found by interpolation. If the mapped position of (y_c, x_c) in the telephoto image **206** lands within the limits of the existing pixels (i.e. $0<=x_T<=C-1$), the pixel value of the composite image **208** at position (y_c, x_c) is found by interpolating pixel values of the telephoto image **206**. Otherwise, the pixel value of the composite image **208** at position (y_c, x_c) is found by interpolating pixel values of the wide image **204**.

[0046] Those skilled in the art will recognize that the above description of producing the values of the composite image **208** using pixel values of the wide image **204** and the telephoto image **206** can be accomplished in many ways. For example, it is easy to pre-calculate the region of pixel locations of the composite image **208** for which the pixel values will be produced by interpolating the telephoto image **206** and the region for which the pixel values will be produced by interpolating the wide image **204**. This saves computational cost but produces the same image data.

[0047] FIG. **6** shows an example set of images. The wide image **204** covers a wide portion of the scene and the telephoto image **206** covers a smaller portion of the scene, but with greater resolution. The produced composite image **208** uses pixel data from the telephoto image **206** for those portions (i.e. the region within the dashed line **220**) that are in the view of the telephoto image **206** and uses pixel data from the wide image **204** otherwise (i.e. the region outside the dashed line **220**). The dashed line **220** shows where the transition is. Thus, the composite image **208** has higher resolution in the interior and lower resolution on the edges. Since the subject of a photograph, especially in consumer photography, is likely to be near the center of the scene, the subject of the composite image **208** is likely to have the highest resolution. It has also been experimentally determined that the transition within the composite image **208** between pixels derived by interpolating the wide image **204** versus the telephoto image **206** does not product visually objectionable artifacts.

[0048] Since lenses **2** and **3** are separated by some distance, it is possible that objects very close to the camera will appear to have a discontinuity at the transition. In this case, it is possible to use standard image processing techniques to

find objects that are close to the camera and to process these regions in a fashion that does not produce a discontinuity artifact. For example, the pixel values of the composite image **208**, for objects that are close to the camera and span the transition region, can be determined by interpolating the wide image **204**. A true depth map can also be created and used by the image resampler **214** to sample the appropriate locations within the telephoto image **206** and the wide image **204**. In this case, the registration model is no longer a simple scale translation model.

[0049] A further feature of the present invention is that the composite image **208** can be stored on the camera without digital zooming. Therefore, digital zooming of the composite image **208** can be (lone later, during post processing, to create an image for use by the operator for printing or sharing. The composite image **208** can be formed during image processing on the camera or later during post processing when the images have been offloaded from the camera. To enable the composite image to be formed during post processing, the wide image **204** and the telephoto image **206** must both be stored at the time of image capture.

[0050] The invention can also be applied to a series of sequential images as in a video. Referring to FIG. **7**, in the case of video, two sets of video images, wide video images **220** and telephoto video images **222** are captured substantially simultaneously from the two lenses **2** and **3** or **2** and **4** and the two image sensors **12** and **14** providing video images from a short focal length lens **2** and a zoom lens **3** or a longer second focal length lens **4**. The composite video **224** is formed by combining the two sets of video images **220** and **222**. The composite video **224** can be formed during image processing on the camera and stored on the camera or the composite video **224** can be formed later during post processing when the images have been offloaded from the camera. To enable the composite video **224** to be formed during post processing, the wide video images **220** from the short focal length lens **2** and the telephoto video images **222** from the zoom lens **3** or the longer focal length lens **4** must both be stored at the time of image capture. Digital zoom of the video images can be accomplished on the camera during capture, or on the camera after capture, or during post processing after the composite video **224** has been offloaded from the camera or during post processing when the composite video **224** is being formed.

[0051] The processed digital image file is provided to a memory card interface **52**, which stores the digital image file on the removable memory card **54**. Removable memory cards **54** are one type of removable digital image storage medium, and are available in several different physical formats. For example, the removable memory card **54** can include (without limitation) memory cards adapted to well-known formats, such as the Compact Flash, SmartMedia. MemoryStick, MMC, SD, or XD memory card formats. Other types of removable digital image storage media, such as magnetic hard drives, magnetic tape, or optical disks, can alternatively be used to store the still and motion digital images. Alternatively, the digital camera **10**A can use internal non-volatile memory (not shown), such as internal flash EPROM memory to store the processed digital image files. In such an embodiment, the memory card interface **52** and the removable memory card **54** are not needed.

[0052] The image processor **50** performs various image processing functions, including color interpolation followed by color and tone correction, in order to produce rendered sRGB image data. The rendered sRGB image data is then JPEG compressed and stored as a JPEG image file on the removable memory card **54**. The rendered sRGB image data can also be provided to a host PC **66** via a host interface **62** communicating over a suitable interconnection, such as a SCSI connection, a USB connection or a Firewire connection. The JPEG file uses the so-called "Exif" image format defined in "Digital Still Camera Image File Format (Exit)" version 2.1, July 1998 by the Japan Electronics Industries Development Association (JEIDA), Tokyo, Japan. This format includes an Exif application segment that stores particular image metadata, including the date or time the image was captured, as well as the lens f/number and other camera settings.

[0053] It should be noted that the image processor **50**, although typically a programmable image processor, can alternatively be a hard-wired custom integrated circuit (IC) processor, a general purpose microprocessor, or a combination of hard-wired custom IC and programmable processors.

[0054] The image processor **50** also creates a low-resolution "thumbnail" size image, which can be created as described in commonly-assigned U.S. Pat. No. 5,164,831, entitled "Electronic Still Camera Providing Multi-Format Storage Of Full And Reduced Resolution Images" issued in the name of Kuchta, et al., the disclosure of which is herein incorporated by reference. After images are captured, they can be quickly reviewed on a color LCD image display **70** by using the thumbnail image data. The graphical user interface displayed on the color LCD image display **70** is controlled by the user controls **42**.

[0055] In some embodiments of the present invention, the digital camera **10**A is included as part of a camera phone. In such embodiments, the image processor **50** also interfaces to a cellular processor **90**, which uses a cellular modem **92** to transmit digital images to a cellular network (not shown) using radio frequency transmissions via an antenna **94**. In some embodiments of the present invention, the image capture assembly **1** can be an integrated assembly including the lenses **2** and **3**, the image sensors **12** and **14**, and zoom and focus motors **5**. In addition, the clock drivers **13** and **15**, as well as the analog signal processors **22** and **24**, the digital multiplexer **37**, and the A/D converters **34** and **36**, can be part of the integrated assembly.

[0056] FIGS. **2**A and **2**B show perspective views of the digital camera **10**A and **10**B described in relation to FIGS. **1**A and **1**B respectively. FIG. **2**A is a front view of the digital camera **10**A, showing the fixed focal length lens **2**, and the zoom lens **3** and flash **48**. The fixed focal length lens **2** is preferably a very short focal length lens so that the camera can be very thin. Other lens focal lengths and lens type constructions are within the scope of the invention.

[0057] FIG. **2**B is a rear view of the digital camera **10**A. The various operator controls for the user interface are shown as **42***a*, **42***c* and **42***d*. The display for viewing the images is shown as **70**. The aspect ratio of the display is typically 4:3 but can be any other ratio.

[0058] In a further preferred embodiment, as shown in FIG. **1**B, digital camera **10**B includes an adjustable focal lens system with two fixed focal length lenses **2** and **4**, each providing an image to a corresponding image sensor **12** and **14**. The digital camera **10**B is capable of simultaneous image capture on both image sensors **12** and **14**. The two fixed focus lenses are selected to provide a substantial zoom range, for example, 3:1 wherein the focal length of the

second fixed focal length lens **4** is 3× as long as the fixed focal length lens **2**. As in digital camera **10**A, a composite image is constructed from the two images captured on images sensors **12** and **14**. Digital zoom is applied to the composite image between the image captured with the short fixed focal length lens **2** on first image sensor **12** and the image captured with the longer second fixed focal length lens **4** on second image sensor **14**. The zoom control **42***c* can provide zoom settings over the zoom range, for example, from 1 to 3. The remaining aspects of the digital camera **10**B are similar to the digital camera **10**A shown in FIG. **1**A, and retain the same reference characters. Reference is therefore made to FIG. **1**B for further description of these aspects of the digital cameras **10**B.

[0059] A number of advantages can be obtained by use of the fixed focal length lenses in digital camera **10**B. The aperture of each lens can be kept quite large (e.g., f/2.8 at least for the widest angle lens), thereby providing a high speed, low light lens. In addition, the image quality of the optical assembly can be kept higher and at a lower manufacturing cost than for a comparable zoom lens. When digital zooming is employed, there are no moving parts for the zoom—even though there are multiple zoom settings—and the zoom is completely silent and relatively fast in zoom focal length transitions. In addition, the overall size of the image module including both fixed focus lenses and both image sensors is very compact which makes this embodiment important for cell phone cameras and other applications in which size is critical.

[0060] In many of the foregoing embodiments, digital zooming is used. Digital zooming is a well-known process and can be constructed using a variety of techniques. One such digital zooming capability is described in commonly-assigned pending U.S. Patent Application Publication No. 2003/0202113, "Electronic Still Camera and Image Processing Method" filed on Aug. 1, 2002 in the name of Sumito Yoshikawa and which is incorporated herein by reference. For the type of system disclosed in this pending patent application, as well as for the system according to the present invention, the image sensor includes an array of discrete light sensitive picture elements overlaid with a color filter array (CFA) pattern to produce color image data corresponding to the CFA pattern. The output data from the image sensor is applied to an analog signal processing (ASP) and analog/digital (A/D) conversion section, which produces digital CFA data from the color image data.

[0061] The resultant digital data is applied to a digital signal processor, such as the image processor **50** (referring to FIGS. **1**A and **1**B of the present invention), which interpolates red, green, and blue (RGB) color image data for all of the pixels of the color image sensor. The CFA image data represents an image of a fixed size, such as 2048 columns of pixels×1536 rows of pixels. A digitally zoomed image is created by taking the center section of the CFA image data and interpolating any additional pixels that fall in between the pixels provided by the image sensor. For example, a 2:1 digital zoom is provided by using only the center 1024 columns×768 rows of the CFA image data and interpolating one additional row and column in between each of the rows and columns of the center CFA image data so as to enlarge the center of the image. The output of the image processor **50** is a color interpolated and digitally zoomed image, with 2048 columns and 1536 rows of RGB data, provided from the center 1024 columns×768 rows of CFA image data.

[0062] To operate the present imaging system according to the teaching of the aforementioned Yoshikawa patent, the user operates the digital camera, e.g., the digital camera **10**A or **10**B, to take pictures while observing the image on the color LCD image display **70**. The digital CFA image for each of the captured images is processed by the image processor **50** and displayed in a "thumbnail" or subsampled format in the preview step. If the observed zoom amount is not desired, the user then changes the zooming/cropping setting in a zoom selection or cropping step by using the zoom button **42***c*. For example, a 2.5:1 overall zoom setting can be provided by using the center 1638 columns×1230 rows from the 2048 columns×1536 rows of CFA image data. The composite image will then contain more columns and rows of image data in the central area where the image captured with the longer focal length lens is located.

[0063] In a preferred embodiment, the image produced on the color LCD image display (**70**) is derived from the composite image containing data from both the wide image and the telephoto image. In an alternative embodiment, the image on the color LCD image display can be derived entirely from the wide image to reduce the computational requirements for producing the LCD image.

[0064] Multiple lenses and multiple sensors, and the use of an integrated image capture assembly, can be adapted for use in a cell phone of the type having a picture taking capability. Accordingly, and as shown in FIG. **3**A, a cell phone **600** includes a phone stage comprising a microphone **602** for capturing the voice of a caller, related electronics (not shown) for processing the voice signals of the caller and the person called, and a speaker **604** for reproducing the voice of the person called. A keypad **606** is provided for entering phone numbers and image capture commands and a (LCD) display **608** is provided for showing phone-related data and for reproducing images captured by the phone or received over the cellular network. The rear view of the cell phone **600** shown in FIG. **3**B identifies some of the internal components, including a cellular image capture assembly **610** connected via the image processor **50** (as shown in FIGS. **1**A and **1**B) to a cellular processing stage comprising the cellular processor **90** and the cellular modem **92**. The cellular processor **90** receives and processes the image data from the image processor **50** and the voice data captured by the microphone **602**, and transfers the image and voice data to the cellular modem **92**. The cellular modem **92** converts the digital image and voice data into the appropriate format for transmission by the antenna **94** to a cellular network.

[0065] The cellular image capture assembly **610** as shown in FIGS. **4**A and **4**B, where FIG. **4**B is a top view of the cellular image capture assembly **610** taken along the lines **24**B-**24**B in FIG. **4**A, comprises an integrated packaging of the optical and imaging components on a common substrate **620**. More specifically, the cellular image capture assembly **610** includes a first fixed focal length lens **612** and a first image sensor **614**, and a second fixed focal length lens **616** and a second image sensor **618**. The first fixed focal length lens **612**, preferably a fixed focal length wide angle lens, forms an image on the first image sensor **614**, and the second fixed focal length lens **616**, preferably a fixed focal length telephoto lens with a longer focal length, forms an image on the second image sensor **618**. Both of the lenses are oriented

in the same direction in order to form images of the same portion of the overall scene in front of them, but different fields of view.

[0066] Each fixed focal length lens **612** and **616** and each associated image sensor **614** and **618** are mounted to the substrate **620** with an IR cut filter **622** in between to reduce the incidence of IR radiation on the image pixels. Electronic components **624**, such as resistors, capacitors and power management components, are also mounted on the substrate **620**. A flex connector **626** is used to take the image data from the substrate **620**. The data can be raw image data or, if suitable processors (not shown) are on board the substrate **620**, YUV image data or JPEG image data. Moreover, the image processor **50** can provide digital zooming between the wide angle and the telephoto focal lengths; the user can initiate such zooming via a user interface displayed on the (LCD) display **608** and by keying appropriate buttons on the keypad **606**. Furthermore, the wide-angle image sensor **614** can have high resolution, e.g., higher than that of the telephoto second image sensor **618**, in order to provide a higher quality source image for the digital zooming.

[0067] In one embodiment, the wide angle first fixed focal length lens **612** is set to its hyperfocal distance, which means it is in focus from a few feet to infinity without need for any focus adjustment by the user. The telephoto second fixed focal length lens **616** is automatically focused by an auto focus subsystem **628** because the hyperfocal distance increases as the focal length increases requiring that the focus be adjusted in order to obtain proper focus for objects at typical (e.g. 4' to 12') distances. By using only one focusing subsystem **628** for the telephoto second fixed focal length lens **616**, the cost and size can be reduced.

[0068] In this embodiment the “z” dimension **630** can be reduced consistent with cell phone layout and architecture. Careful choice of the telephoto focal length, the use of a folded optical path and the size of the sensor can further reduce the “z” dimension **630**. For example, the size of the second image sensor **618**, and consequently the size of the image that must be produced to fill the sensor, can be made small enough to reduce the focal length to an acceptable “z” dimension **630**.

[0069] Although not shown in detail in FIGS. **4**A and **4**B, but similarly, as was explained in connection with FIG. **3**, an analog output signal from the first image sensor **614** is amplified by a first analog signal processor and provided to a first A/D converter to produce the first digital image data. The first digital image data is provided to the digital multiplexer and the DRAM buffer memory. Similarly, the analog output signal from the second image sensor **618** is amplified by a second analog signal processor and converted to a second digital image data by a second A/D converter. The second digital image data is then provided to the digital multiplexer and the DRAM buffer memory. The first digital image data and the second digital image data are both provided to an input of the image processor wherein the composite image is formed by combining portions of the two images. Wherein the A/D converters, the digital multiplexer, the DRAM buffer memory, and the image processor are provided as electronic components **624** on the substrate **620**. The digital zooming of the composite image is done in accordance with the setting of the zoom control.

[0070] It is a feature of the invention that by simultaneously capturing two images, of the same scene but different fields of view and different resolutions, a composite image can be formed without having to account for camera motion or motion within the scene. In the case of photographing objects in a scene that are positioned near the camera, adjustments will have to be made for parallax when the two lenses are separated by a substantial distance. This issue will only surface when objects in the scene are very near to the camera. However, in a further preferred embodiment, the two lenses will share a common optical axis to avoid parallax issues between the two images.

[0071] The invention has been described in detail with particular reference to certain preferred embodiments thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention.

PARTS LIST

[0072] **2** fixed focal length lens
[0073] **3** zoom lens
[0074] **4** second fixed focal length lens
[0075] **5** zoom and focus motors
[0076] **6** focus motors
[0077] **10**A digital camera (first embodiment)
[0078] **10**B digital camera (second embodiment)
[0079] **12** first image sensor
[0080] **12***e* first image output signal
[0081] **13** clock drivers
[0082] **14** second image sensor
[0083] **14***e* second image output signal
[0084] **15** clock drivers
[0085] **22** first analog signal processor (ASP**1**)
[0086] **24** second analog signal processor (ASP**2**)
[0087] **34** first A/D converter
[0088] **36** second A/D converter
[0089] **37** digital multiplexer
[0090] **38** DRAM buffer memory
[0091] **40** control processor and timing generator
[0092] **42** user controls
[0093] **42***a* shutter button
[0094] **42***c* zoom button
[0095] **42***d* multi-position selector
[0096] **46** automatic focus and automatic exposure detectors
[0097] **48** electronic flash
[0098] **50** image processor
[0099] **52** memory card interface
[0100] **54** removable memory card
[0101] **56** RAM memory
[0102] **58** firmware memory
[0103] **62** host interface
[0104] **64** interconnection
[0105] **66** host PC
[0106] **70** color LCD image display
[0107] **90** cellular processor
[0108] **92** cellular modem
[0109] **94** antenna
[0110] **202** image compositor
[0111] **204** wide image
[0112] **206** telephoto image
[0113] **208** composite image
[0114] **210** zoom amount
[0115] **212** image registration determiner
[0116] **214** image resampler
[0117] **220** wide video images
[0118] **222** telephoto video images

[0119] **224** composite video
[0120] **600** cell phone
[0121] **602** microphone
[0122] **604** speaker
[0123] **606** keypad
[0124] **608** (LCD) display
[0125] **610** cellular image capture assembly
[0126] **612** first fixed focal length lens
[0127] **614** first image sensor
[0128] **616** second fixed focal length lens
[0129] **618** second image sensor
[0130] **620** substrate
[0131] **622** IR cut filter
[0132] **624** electronic components
[0133] **626** flex connector
[0134] **628** auto focus subsystem
[0135] **630** z dimension

1. A method of producing a digital image having portions with different resolutions comprising:

(a) simultaneously capturing first and second digital images of the same scene wherein the first digital image is of a larger portion of the scene than the second digital image wherein the second digital image has a higher resolution than the resolution in the first digital image corresponding to the second digital image; and

(b) combining at least a portion of the second digital image into the corresponding portion of the first digital image to thereby provide a digital image having portions with different resolutions.

2. The method of claim **1** further including providing an image capture device having two lens systems and two image sensors, each lens system corresponding to a different one of the image sensors.

3. The method of claim **2** wherein each lens system includes at least one fixed focal length lens.

4. The method of claim **2** wherein one of the lens systems is an adjustable focal lens system.

5. A method for operating an image capture device to produce a digital image having portions with different resolutions comprising:

(a) providing an image capture device having an image processor, two lens systems, and two image sensors, each lens system corresponding to a different one of the lens systems:

(b) operating the image capture device to simultaneously capture first and second digital images of the same scene wherein the first digital image is of a larger portion of the scene than the second digital image wherein the second digital image has a higher resolution than the resolution in the first digital image corresponding to the second digital image; and

(c) using the image processor to stitch at least a portion of the second digital image into a corresponding portion of the first digital image providing a composite digital image having portions with different resolutions.

6. The method of claim **5** further including adjusting the zoom lens prior to image capture.

7. The method of claim **5** wherein each lens system includes at least one fixed focal length lens.

8. The method of claim **5** wherein one of the lens systems is an adjustable focal lens system.

9. The method of claim **5** wherein the two lens systems have a common optical axis.

10. The method of claim **5** wherein element (c) further includes using a zoom amount to stitch the first digital image and the second digital image.

11. The method of claim **5** wherein the composite digital image is a series of video images wherein each digital image in the video has different resolutions.

* * * * *

US008896697B2

(12) **United States Patent**
Golan et al.

(10) **Patent No.: US 8,896,697 B2**
(45) **Date of Patent: Nov. 25, 2014**

(54) **VIDEO MOTION COMPENSATION AND STABILIZATION GIMBALED IMAGING SYSTEM**

(76) Inventors: **Chen Golan**, Ein Vered (IL); **Boris Kipnis**, Tel-Aviv (IL)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 586 days.

(21) Appl. No.: **13/259,250**

(22) PCT Filed: **Apr. 6, 2010**

(86) PCT No.: **PCT/IL2010/000280**

§ 371 (c)(1), (2), (4) Date: **Sep. 23, 2011**

(87) PCT Pub. No.: **WO2010/116366**

PCT Pub. Date: **Oct. 14, 2010**

(65) **Prior Publication Data**

US 2012/0019660 A1 Jan. 26, 2012

Related U.S. Application Data

(60) Provisional application No. 61/167,226, filed on Apr. 7, 2009.

(51) **Int. Cl.**
H04N 7/18 (2006.01)
H04N 5/232 (2006.01)
H04N 5/262 (2006.01)

(52) **U.S. Cl.**
CPC ***H04N 5/23258*** (2013.01); ***H04N 5/23248*** (2013.01); ***H04N 5/232*** (2013.01); ***H04N 5/23264*** (2013.01); ***H04N 5/2628*** (2013.01)
USPC **348/144**

(58) **Field of Classification Search**
CPC H04N 5/23248; H04N 5/23258; H04N 5/232; H04N 5/23264; H04N 5/2628; G02B 27/646; G01C 11/025
USPC 348/144, 208.4
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2008/0151064 A1 * 6/2008 Saito et al. 348/208.4

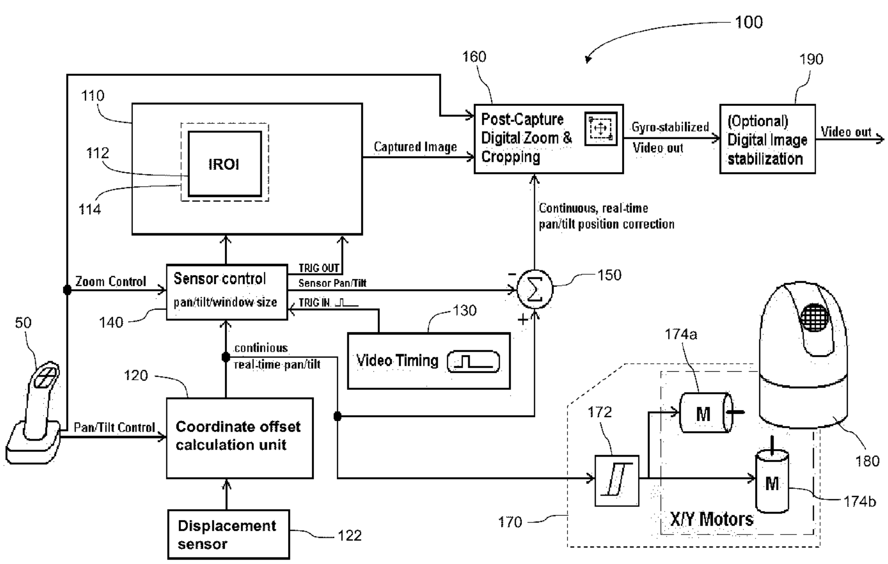
* cited by examiner

Primary Examiner — Allen Wong

(57) **ABSTRACT**

A system and method for compensating for image distortions formed by the motion of a computerized camera system mounted on a moving platform. The camera system includes a camera, wherein the camera acquires a plurality of image frames including images of the environment viewed from within the field of view of the camera. The distortion is formed in the acquired image frame, during and in between image acquisitions. During the image acquisition the camera may be maneuvered in space, typically, in the pan and tilt axis. The method includes the steps of providing camera maneuvering signals, providing sensors for detecting other motions of the camera, computing the pre acquisition aggregated motion vector of the camera, thereby determining the pre acquisition image distortion, and compensating for the determined pre acquisition image distortion by an equivalent vector, in a direction opposite to the direction of the pre acquisition aggregated motion vector.

46 Claims, 5 Drawing Sheets



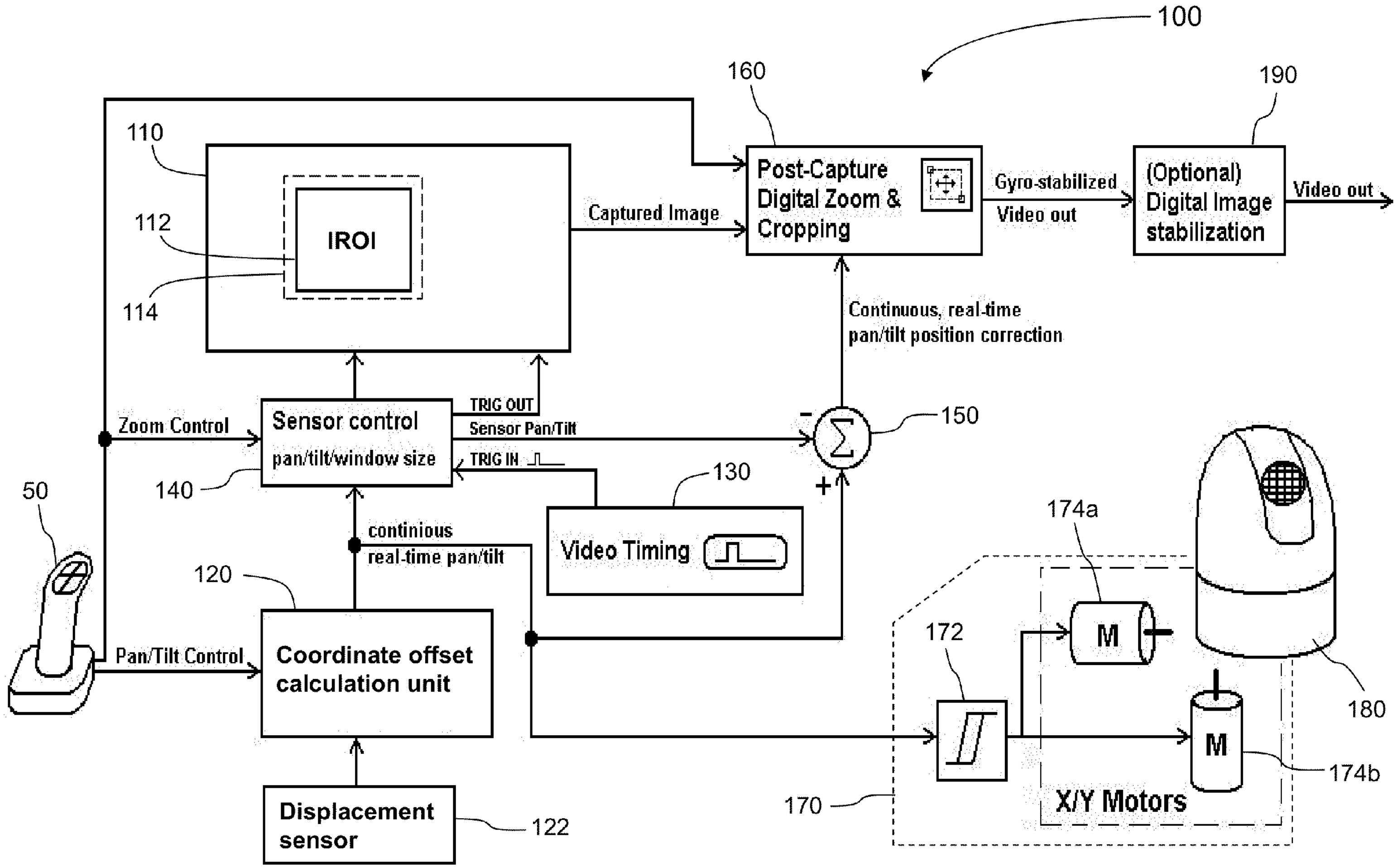

100
160
190
110
Post-Capture
Digital Zoom &
Cropping
Gyro-stabilized
Video out
(Optional)
Digital Image
stabilization
Video out
112
IROI
Captured Image
114
Continuous, real-time
pan/tilt position correction
Sensor control
pan/tilt/window size
TRIG OUT
Sensor Pan/Tilt
TRIG IN
Zoom Control
150
140
50
130
Video Timing
continious
real-time pan/tilt
120
174a
Coordinate offset
calculation unit
Pan/Tilt Control
172
M
M
180
174b
170
X/Y Motors
Displacement
sensor
122

Fig 1

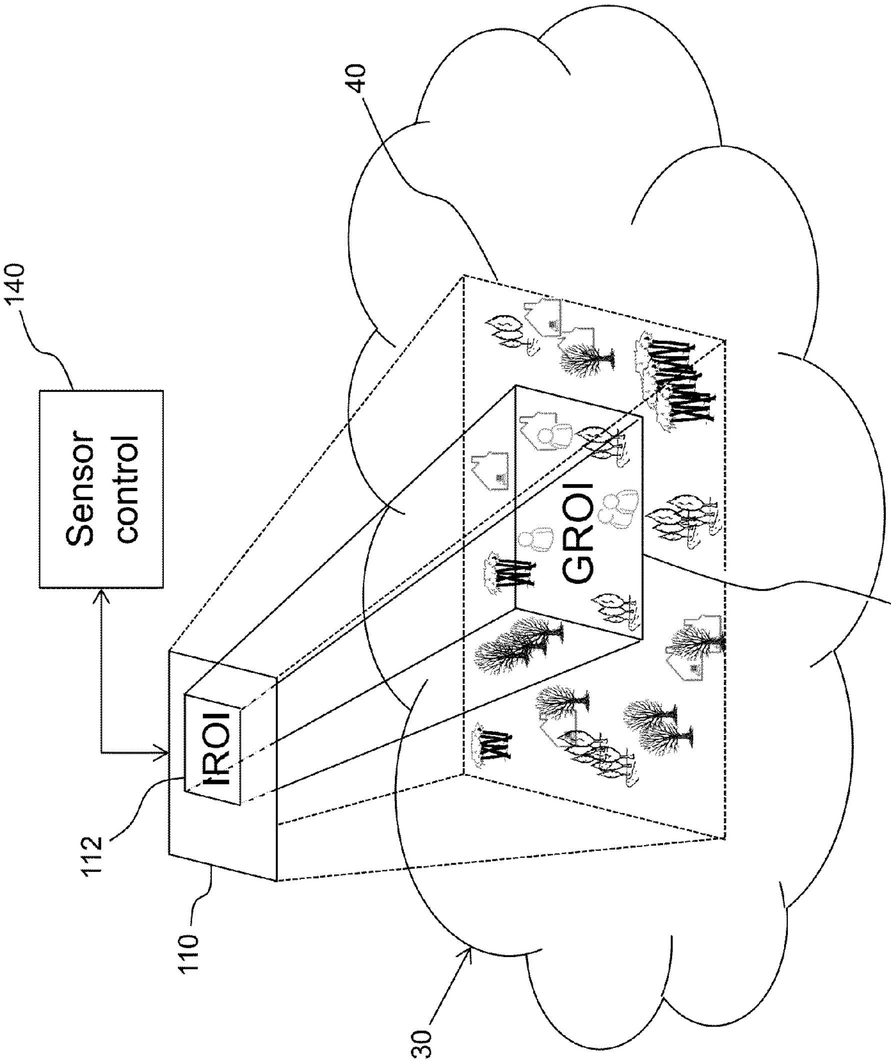


Fig 2

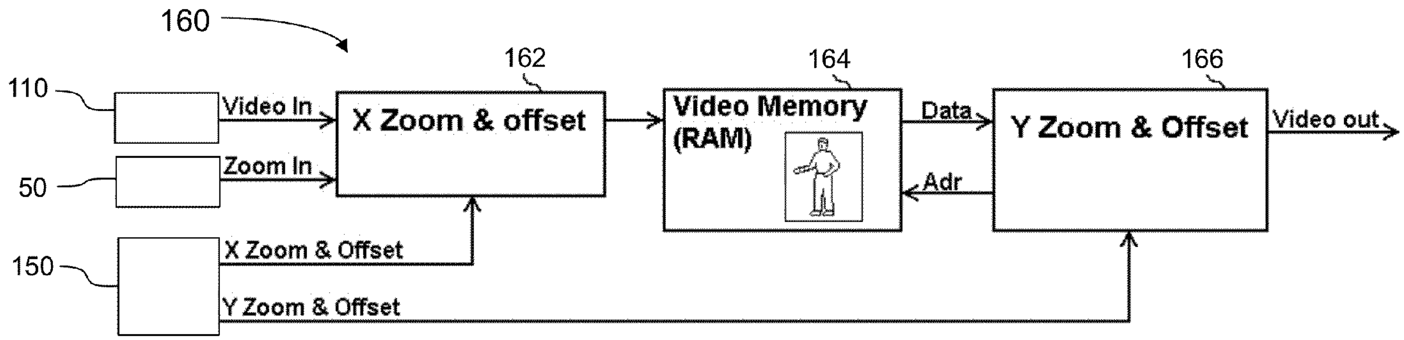

160
110
Video In
X Zoom & offset
162
Video Memory
(RAM)
164
Data
Adr
Y Zoom & Offset
166
Video out
50
Zoom In
150
X Zoom & Offset
Y Zoom & Offset

Fig 3

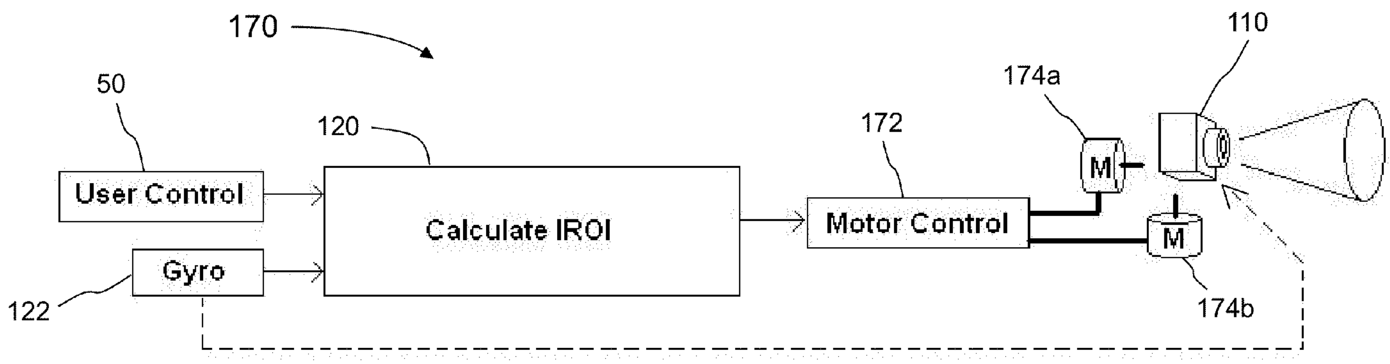

170
50
User Control
120
Calculate IROI
Gyro
122
172
Motor Control
174a
M
M
174b
110

Fig 4

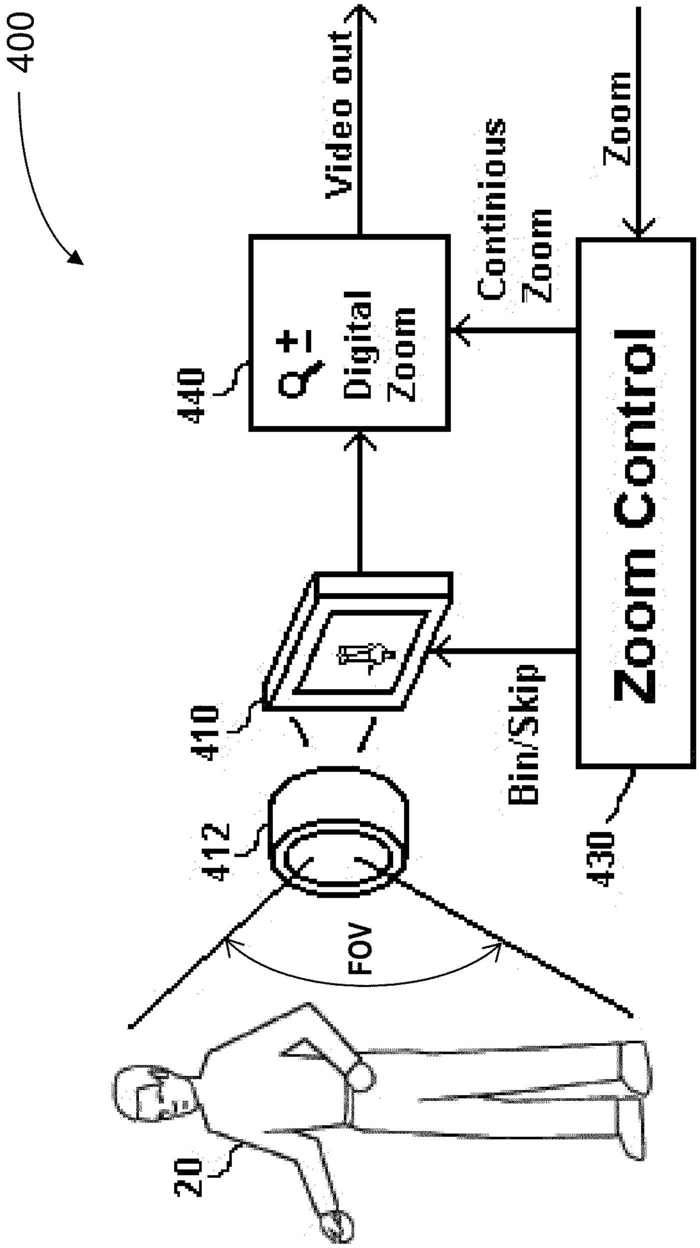

400
Video out
Continious Zoom
Zoom
Digital Zoom
440
Zoom Control
Bin/Skip
410
412
430
FOV
20

Fig 5

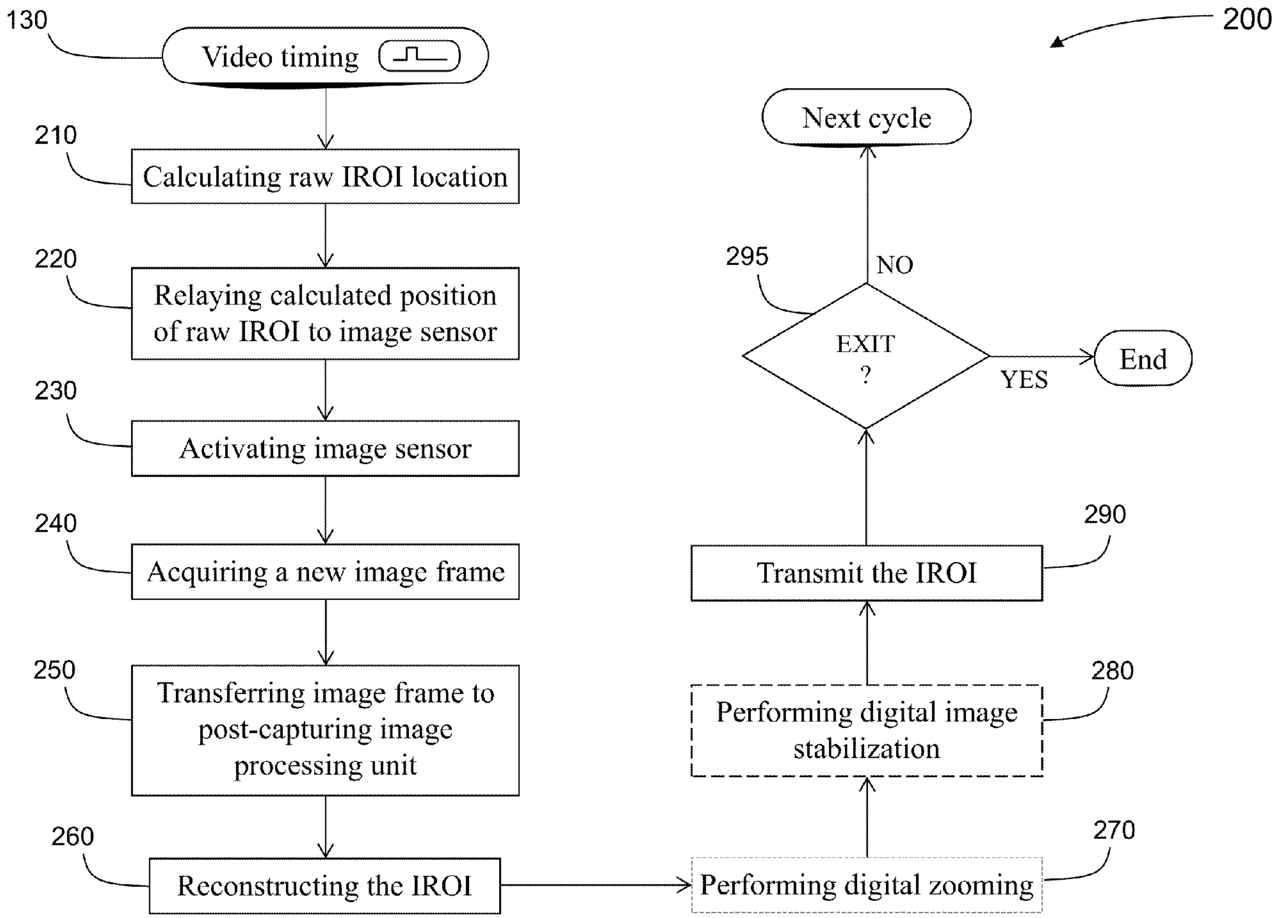

200
130
Video timing
210
Calculating raw IROI location
220
Relaying calculated position of raw IROI to image sensor
230
Activating image sensor
240
Acquiring a new image frame
250
Transferring image frame to post-capturing image processing unit
260
Reconstructing the IROI
270
Performing digital zooming
280
Performing digital image stabilization
290
Transmit the IROI
295
EXIT ?
NO
YES
Next cycle
End

Fig 6

VIDEO MOTION COMPENSATION AND STABILIZATION GIMBALED IMAGING SYSTEM

RELATED APPLICATION

The present application claims the benefit of U.S. provisional application 61/167,226 filed on Apr. 7, 2009, the disclosure of which is incorporated herein by reference.

FIELD OF THE INVENTION

The present invention relates to imaging systems, and more particularly, the present invention relates to an imaging system, operatively mounted on an air-born vehicle, that can transmit high resolution images of a selected region of interest, whereas the images are continuously compensated for vehicle motion.

BACKGROUND OF THE INVENTION AND PRIOR ART

An image sensor is generally subject to motion and vibrations which might distort a detected image of a scene. The motion can be linear, where the image sensor undergoes a linear displacement or scaling, and the motion can be angular, where the image sensor rotates about one or more axes. In case of an image sensor mounted on a marine vessel, the image can be distorted as a result of ocean waves. Likewise, image distortion can occur in images detected by an image sensor mounted to a ground vehicle, an airborne platform, such as an aircraft, a helicopter or a satellite.

Methods for compensating for the vibrations and noise in order to obtain a stabilized image are known in the art. For example, a gyroscope connected to the image sensor detects the inertial rotations of the image sensor, and a servo system (including a servo motor and a controller) rotates the gimbals on which the image sensor is mounted, in the opposite direction and by the same amount, according to the output of the gyroscope. The image can be further refined by employing additional gyroscopes and by providing each gyroscope additional degrees of freedom.

Prior art imaging systems are typically large in size and thereby in relative weight. Furthermore, prior art imaging systems require extensive image processing on the whole image frame acquired, particularly for high resolution imaging systems.

There is a need for and it would be advantageous to have image sensors, mounted on an airborne vehicle, such as unmanned aerial vehicle (UAV), having high resolution and capability to select in real the region-of-interest (ROI), low cost, low weight and low power consumption.

SUMMARY OF THE INVENTION

The present invention describes a motion-compensation and stabilization gimbaled camera system for performing image acquisition and image transmission. The present invention is often described herein in terms of an air-born camera system, but the present invention is not limited to an air-born motion compensation and stabilization gimbaled camera system, and the system can be used in any video acquisition system, such as on hand held cameras, land-vehicle mounted, traffic control systems, waterways-vehicle mounted, etc.

According to teachings of the present invention, there is provided a camera system including camera motion compensation and stabilization units, using a high resolution image

sensor, such as a multi-megapixel CMOS ("CMOS image sensor") or a camera module with digital pan, tilt and optionally zoom capability, mounted on a moving platform and having a simple mechanical gimbals support. The camera system facilitates, each time before an image is captured, to compensate for unwanted image motion or jitter caused by the camera platform motion, by pointing to relevant image array region corresponding to a selected geographical region of interest, just before capturing the image. The correct window offset is calculated using platform angular motion sensors, such as gyro or rate-gyro.

According to further teachings of the present invention, there is provided a method for compensating for image distortions formed by the motion of a computerized camera system mounted on a moving platform. The camera system includes a camera having one or more image sensor arrays, wherein the camera acquires consecutively, in real time, a plurality of image frames including images of the environment viewed from within the field of view of the camera. The distortion is formed in the acquired image frame, during and in between image acquisitions. During the image acquisition the camera may be maneuvered in space, typically, in the pan and tilt axis. The platform can be an air born vehicle, a land vehicle, a waterway vehicle, a living body, carried by hand or any other moving and/or vibrating platform.

The method for compensating for image distortions in the acquired image frames includes the steps of providing camera maneuvering signals, providing one or more sensors for detecting the motion of the camera, computing the pre acquisition aggregated motion vector of the camera, thereby determining the pre acquisition image distortion caused by the pre acquisition aggregated motion vector of the camera, compensating for the determined pre acquisition image distortion by a magnitude equal to the magnitude of the pre acquisition aggregated motion vector, in a direction opposite to the direction of the pre acquisition aggregated motion vector, and acquiring an image frame.

The camera maneuvering signals are maneuvering commands as provided by the steering control of the camera.

The one or more sensors are typically displacement sensors for sensing changes in spatial position such as angular rate sensors, gyroscope sensors, rate gyroscope sensors or smart inertial navigation system units.

Preferably, the method further includes the steps of providing an environmental region of interest within the environment viewed from within the field of view of the camera, and determining the array of pixels being a portion of the one or more image sensor arrays acquiring the image of the environmental region of interest and thereby obtaining an image region of interest. The compensation for the determined pre acquisition image distortion is performed on the image region of interest.

Optionally, the method for compensating for image distortions in the acquired image frames includes steps for further compensating for distortions not attended by the pre acquisition compensation steps. The method further includes post acquisition compensation steps of determining the post acquisition image distortion caused by the detected motion of the camera from the instant of issuing of a command for acquiring an image frame until the actual acquisition of the image frame, and compensating for the determined post acquisition image distortion, wherein the compensation for the determined post acquisition image distortion is applied to the image region of interest, whereby creating a final image region of interest. The compensation for the determined post acquisition image distortion is performed by a magnitude equal to the magnitude of the post acquisition aggregated

motion vector and in a direction opposite to the direction of the post acquisition aggregated motion vector.

Preferably, the method further includes the steps of padding the image region of interest with a predefined margin, before determining the post acquisition image distortion, and cropping the image region of interest to remove the margin, after compensating for the determined post acquisition image distortion, and before forming the final image region of interest.

Optionally, when using a camera having a rolling shutter, the method further includes the steps of determining the rolling shutter image distortion, typically a wobble distortion, and compensating for the determined rolling shutter image distortion in an opposite direction to the direction of the rolling shutter image distortion for each line or pixel in the image region of interest. It should be noted that determining the rolling shutter image distortion and the compensation for the determined rolling shutter image distortion are performed in either line, pixel or sub-pixel resolution.

In embodiments of the present invention, the compensation for the determined rolling shutter image distortion are performed in the X-axis by line shifts to the opposite direction of the rolling shutter motion during the image acquisition scan.

In embodiments of the present invention, the compensation for the determined rolling shutter image distortion is performed in the Y-axis by calculating and changing the line to line distances.

Optionally, the method further includes the steps of providing a zooming mechanism, providing a zoom request including zoom parameters, and computing the final image region with the provided parameters of the zoom request. The zooming mechanism can be an optical zoom, an electronic zoom or a combination of optical zoom and electronic zoom.

It should be noted that the resolution of the acquired image frame may be larger than the resolution of the image region of interest and the final image region of interest. It should be noted that the original resolution of the acquired image frame may be extended using digital zooming methods.

Optionally, the method for compensating for image distortions in the acquired image frames includes steps for further compensating for distortions not attended by the pre acquisition compensation steps and the post acquisition compensation steps. The method further includes the steps of providing a digital image stabilization unit, determining residual image distortions, and compensating for the residual image distortions. The step of determining of residual image distortions includes computing the correlation between a previously computed final image region of interest and the currently computed final image region of interest.

Preferably, after completion of the post acquisition compensation steps the final image region of interest is transmitted to a predetermined video receiving unit, typically a remote video receiving unit.

The camera system my further include a motorized mechanical gimbal that extends the camera dynamic range with an additional degree of freedom. The motorized mechanical gimbal can be operated by a variety of motors, including a step motor, a DC motor, a brushless motor, etc., and is preferable operated by a DC motor with pulse width modulation, to control motor force and speed.

In variations of the present invention, in a computerized gimbaled camera system, the method further includes the step of activating the motorized mechanical gimbal to maintain the central pixel of the image region of interest, representing the center of the environmental region of interest, within a distance less than a predefined threshold value from the center of the image sensor array.

In variations of the present invention, in a computerized gimbaled camera system, the method further includes the steps of computing the distance of each edge of the image region of interest from the respective edge of the image sensor array, and activating the motorized mechanical gimbal to maintain each of the edges of the image region of interest at a distance less than a predefined threshold value from the respective edge of the image sensor array. Optionally, the computation of the distance of each of the edges of the image region of interest, from the respective edge of the image sensor array, uses a hysteresis function. The hysteresis values of the hysteresis function may be calculated as a function of zoom and motion changes prediction.

An aspect of the present invention is to provide a computerized camera system mounted on a moving platform, optionally having a steering control, for compensating for image distortions in the acquired image frames, wherein the distortions are caused by movements and/or vibrations of the camera.

The computerized camera system includes a camera having one or more image sensor arrays, wherein the camera acquires consecutively, in real time, a plurality of image frames including images of the environment viewed from within a field of view of the camera, the camera system including a coordinate offset calculation unit, a camera steering control, a displacement sensor, an image sensor configuration control unit, and a video timing unit.

The video timing unit determines the frame acquisition rate of the camera and wherein the video timing unit begins a frame acquisition cycle having a pre acquisition portion and a post acquisition portion. The camera steering control provides tilt and/or pan motional data of the camera. The displacement sensor senses the camera motion in space. The coordinate offset calculation unit continuously aggregates the sensed motions of the camera and thereby determining a pre acquisition aggregated motion vector. The image sensor configuration control unit determines the pre acquisition image distortion caused by the pre acquisition aggregated motion vector. The image sensor configuration control unit compensates for the determined pre acquisition image distortion by a magnitude equal to the magnitude of the pre acquisition aggregated motion vector, in a direction opposite to the direction of the pre acquisition aggregated motion vector.

In preferred embodiments of the present invention, the camera system further includes a computation unit and a post-capturing image processing unit. The coordinate offset calculation unit and the image sensor configuration control unit provide the computation unit with timing on motion data. The computation unit continuously aggregates the sensed motions of the camera from the instant of issuing of a command for acquiring an image frame until the actual acquisition of the image frame and thereby determining a post acquisition aggregated motion vector. The post-capturing image processing unit determines the post acquisition image distortion caused by the post acquisition aggregated motion vector. The post-capturing image processing unit compensates for the determined post acquisition image distortion by a magnitude equal to the magnitude of the post acquisition aggregated motion vector, in a direction opposite to the direction of the post acquisition aggregated motion vector.

In variations of the present invention, the camera systems further includes a mechanism for adjusting the zoom of the camera,

In variations of the present invention, the camera systems further includes a motorized gimbaled device, wherein the motorized gimbaled device extends the camera dynamic range by providing an additional degree of freedom; and

wherein the motorized gimbaled device facilitates maintaining an environmental region of interest within the field of view of the camera.

In variations of the present invention, the camera systems further includes a digital image stabilization unit, wherein the digital image stabilization unit performs final digital image stabilization and small jitter correction.

Preferably, the camera system further includes a transmitter for transmitting the final region of interest to a video receiving unit, typically a remote video receiving unit.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will become fully understood from the detailed description given herein below and the accompanying drawings, which are given by way of illustration and example only and thus not limitative of the present invention, and wherein:

FIG. **1** is a block diagram illustration of an air-born camera system for performing image acquisition and image transmission, according to the preferred embodiments of the present invention;

FIG. **2** is a schematic illustration of an example spatial environment, in which the air-born camera system shown in FIG. **1** operates.

FIG. **3** is a block diagram illustration of the post-capture digital zoom and cropping unit of the air-born camera system, shown in FIG. **1**;

FIG. **4** is a block diagram illustration of the motorized compensation unit, shown in FIG. **1**;

FIG. **5** is a block diagram illustration of a zoom control sub-system for an air-born camera system, according to variations of the present invention; and

FIG. **6** is a data flow diagram illustration one cycle of an image acquisition process, according to variations of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Before explaining embodiments of the invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangement of the components set forth in the host description or illustrated in the drawings.

Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art of the invention belongs. The methods and examples provided herein are illustrative only and not intended to be limiting.

Reference is now made to the drawings. FIG. **1** is a block diagram illustration of an air-born camera system **100** for performing image acquisition and image transmission, according to the preferred embodiments of the present invention. Air-born camera system **100** includes a high resolution digital image sensor (typically, in current state of the art, higher than 1 mega pixels) **110**, a coordinate offset calculation unit **120**, a displacement sensor **122**, a video timing (clock) unit **130**, an image sensor configuration control unit **140**, a computation unit **150**, a post-capturing image processing unit **160**, an X/Y motorized compensation unit **170**, preferably a gimbaled device **180** (on which image sensor **110** is mounted) and optionally, a digital image stabilization unit **190**.

It should be noted that although the present invention is described in terms of a computerized camera system mounted on an air born vehicle, the computerized camera system of the

present invention is not limited to be mounted only on air vehicles. Similar computerized camera systems can be mounted on/in land vehicles, waterway vehicles, carried by a living body, for example by hand, or mounted on any other moving and/or vibrating platform. Similar motion and vibration problems exist in land vehicles, waterway vehicles and other platforms. It should be further noted that typically, the smaller the vehicle is the less stable the vehicle is, whereas an air vehicles for carrying camera are typically small.

Typically, camera system **100** is operatively mounted on an air-born vehicle. When in operation, the air-born vehicle maneuvers to stay in a desired path using a manual or remote steering control. Digital image sensor **110** of camera system **100** may encounter two types of motions which need to be compensated for in order to stabilize the acquired image streams. Digital image sensor **110** has Pan and Tilt degrees of freedom. Regardless of the platform maneuvering, the Pan and Tilt motion of digital image sensor **110** is controlled, on board or remotely, by a camera steering controller **50**. The camera steering signals sent by camera steering controller **50** carry the data regarding the Pan and Tilt motion of digital image sensor **110**. Furthermore, the vehicle typically encounters unstable conditions such as air pockets, and incurs various motions, vibrations and trembling caused by units such as engine, motors etc.

Reference is also made to FIG. **2**, which is a schematic illustration of an example spatial environment, in which camera system **100** operates. In the example shown in FIG. **2**, the array image sensor **110** images a geographical zone **40**, being part of a larger geographical region **30**. The operator selects a geographical region of interest (GROI) **22** which is imaged onto image region of interest (IROI) **112**, being a virtual portion of image sensor **110**. Configuration control unit **140** continuously tracks the position of IROI **112** and maintains IROI **112** within the boundaries of active array of image sensor **110**. It should be noted that GROI **22** may also be selected automatically, for example by tracking a static or moving object. It should be further noted that in some applications, the region of interest is selected from the environment as viewed by the camera. Therefore, the terms “geographical region of interest” and “environmental region of interest” are used herein interchangeably.

To facilitate a high image frame transfer rate, while maintaining high resolution image sampling by a high resolution image sensor, only the portion of the image frame acquired from IROI **112** is preferably transferred to post-capturing image processing unit **160**, for further processing. But, to enable post-capturing image processing unit **160** to perform the post processing task more accurately, a raw IROI **114** is transferred to post-capturing image processing unit **160**, wherein raw IROI **114** is larger than IROI **112** by a predefined margin of pixels.

The camera is controlled by a camera steering controller **50**, manned or remotely, which typically, enables maneuvering the camera in the Pan and Tilt axes. The control can be done manually by an operator or automatically using an object tracker or GPS location. Steering signals, such as “Pan” and “Tilt” signals, corresponding to the respective movements of the camera, as transmitted by camera steering controller **50**, are also provided to coordinate offset calculation unit **120**.

More motional information, such as vibrations and motion resulted from air pockets, is provided to coordinate offset calculation unit **120** by a displacement sensor **122**. Displacement sensor **122** can be, for example, a gyro sensor, preferably a MEMS gyroscope such as a MEMS rate-gyro. Based on the received motion related signals, coordinate offset cal-

culation unit **120** continuously aggregates the pan-tilt coordinate changes of the vehicle. The calculated offset is then used by image sensor configuration unit **140** to reposition IROI **112** upon image sensor array **110**.

Video timing unit **130** generates trigger pulses synchronous with the preselected frame acquisition rate (typically, 25 (PAL) or 30 (NTSC) frames per seconds), wherein the pulses are forwarded to image sensor configuration unit **140**. Image sensor configuration unit **140**, at the arrival of a trigger pulse and after configuring IROI **112** according to the most recent motion calculations, transfers the configuration data along with a “trigger out” signal to image sensor **110**, which in turn acquires a new image frame.

Threshold unit **172** of X/Y motorized compensation unit **170** calculates the distance of each frame-edge of raw IROI **114** from the corresponding frame-edge of the image array of image sensor **110**. Motorized compensation unit **170** is also illustrated in FIG. **4**. If the distance is below a predetermined threshold value, motors **174** operatively move gimbal **180** and thereby image sensor **110** mounted on gimbal **180**, such that the center of raw IROI **114** is repositioned nearer to the center of the image array of image sensor **110**. The motion of motors **174** is derived from the real time data received from coordinate offset calculation unit **120**. In variations of the present invention, motors **174** are continuously activated to keep the center of GROI **22** reflected substantially at the center of image sensor array **110**.

Since there is a time interval (“post acquisition time interval”) between the calculation of the repositioning of IROI **112** and the actual capturing of the image frame, post processing is applied to the captured image, to correct the distortions in the image caused due to camera motions during the post acquisition time interval. The post processing tasks are performed by post-capture image processing unit **160**. Computation unit **150** computes the differences from the instant of issuing of the acquisition command by image sensor configuration unit **140** to image sensor **110** to acquire the next image frame, until the actual acquisition of the next image frame takes place. The differences are caused by various platform motions during the post acquisition time interval, which motions are continuously provided in real time by coordinate offset calculation unit **120**, and which motions are aggregated to form an aggregated motion vector.

It should be noted that when using a global-shutter, the time taken as the acquisition time of an image frame, is preferably the middle of the frame exposure time. When using rolling-shutter image sensor, the time taken as the acquisition time of the image frame, is the middle of current line exposure time. Correction is preferably applied to each scanned line in the image frame.

The calculated differential information is forwarded from computation unit **150** to post-capture image processing unit **160**, as described in the block diagram illustration shown in FIG. **3**. X-axis zoom and offset unit **162** receives the captured image stream from image sensor **110** and alters relevant image regions, in sub-pixel accuracy, as a function of the calculated X-axis zoom and offset. Video memory unit **164** receives and stores image frame lines from “x zoom and offset” unit **162**. Y-axis zoom and offset unit **166** generates and stores an address signal in memory unit **164** with a selected address offset and line-to-line step as a function of the calculated Y-offset and zoom. Preferably, Y-axis zoom and offset unit **166** has a cache memory to calculate and execute zoom and sub-pixel shift operations. Furthermore, post-capture image processing unit **160** is used to remove image jitter and to correct rolling-shutter distortion, caused by time delay between acquisitions of each scanned line.

Optionally, digital image stabilization unit **190** performs final digital image stabilization and small jitter correction, for example, by computing the correlation between the currently processed frame and the previously transmitted frame of a final IROI.

Preferably, the resulting image frame is then cropped to remove the margins added to raw IROI **114** to yield a final IROI, which is then transmitted to a video receiving unit, typically a remote video receiving unit.

Various zoom control sub-systems can be used to control the zoom of an air-born camera system. Reference is made to FIG. **5**, which is a block diagram illustration of zoom control sub-system **400** for an air-born camera system, according to embodiments of the present invention. Zoom control sub-system **400** includes image sensor **410** having lens module **412** having a fixed focal length lens or zoom lens, zoom control module **430** and digital-zoom module **440**. An object **20** is captured by image sensor **410** through lens module **412**. Zoom control unit **430** calculates the most optimal values for image sensor **410**, binning/skip factors and continuous digital-zoom values that are provided to digital-zoom unit **440**. Setting the binning/skip factor and windowing of image sensor **410** allows to keep a suitable frame refresh rate, while digital-zoom unit **440** provides continuous zoom.

A binning function, which function may be provided by the sensor array provider, is a zoom out function that merges 2×2, or 4×4, or 8×8 pixels pixel array, or any other group of pixels, into a single pixel, whereby reducing the image frame dimensions. The binning function may be refined by using algorithms such as “bi-linear” interpolation, “bi-cubic” interpolation and other commonly used digital zoom algorithms. A skip function, which function may also be provided by the sensor array provider, is a zoom out function that allows skipping pixels while reading frame out, whereby reducing the image frame dimensions and decrease the image acquisition time.

Video timing unit **130** generates trigger pulses synchronous with the preselected frame acquisition rate, wherein the pulses are forwarded to image sensor configuration unit **140**. Each such trigger initiates a new cycle of acquiring an image frame. An image acquisition cycle **200**, as outlined in FIG. **6**, includes the following steps:

Step **210**: calculating a new raw IROI **114** location.

The new raw IROI **114** position upon image sensor array **110** is calculated as follows:

new location=previous location+camera steering changes−sensed displacement changes.

Configuration control unit **140** continuously calculates the position of raw IROI **114** to maintain the entire raw IROI **114** within the active array of image sensor **110**. Configuration control unit **140** continuously receives signal from coordinate offset calculation unit **120**, which continuously calculates the pan-tilt coordinate changes of the camera in space, based on motion related signals provided by camera steering controller **50** and displacement sensor **122**, and aggregates the motion related changes to form an aggregated motion vector. The aggregated motion vector is then used by image sensor configuration unit **140** to reposition raw IROI **114** upon image sensor array **110**. It should be noted that the size of raw IROI **114** depends also on the zoom, also calculated in the formation of the motion vector.

Step **220**: relaying calculated position of raw IROI **114** to image sensor **110**.

The newly calculated position of raw IROI **114** upon to image sensor **110** is transmitted to image sensor **110**.

Step **230**: activating image sensor **110**.

Image sensor configuration unit **140** transmits a "trigger out" signal to image sensor **110**, in order to acquire a new image frame.

Step **240**: acquiring a new image frame.

Image sensor **110** acquires a new image frame.

Step **250**: transferring the acquired image frame portion containing raw IROI **114** to post-capturing image processing unit **160**.

The portion of the acquired image frame that was loaded to sensor by image sensor configuration unit **140** as being raw IROI **114** is transferred to post-capturing image processing unit **160**.

Step **260**: reconstructing the IROI **112**.

Post-capturing image processing unit **160** reconstructs IROI **112** from the transmitted raw IROI **114** and signals received from computation unit **150**. Computation unit **150** computes the differences from the instant of issuing of the acquisition command by image sensor configuration unit **140** to image sensor **110** to acquire the image frame, until the actual acquisition of the image frame takes place. The differences are caused by various platform motions during the post acquisition time interval, which motions are continuously provided in real time by coordinate offset calculation unit **120**, and which motions are aggregated to form an aggregated motion vector. Post-capturing image processing unit **160** reconstructs IROI **112** based on the aggregated motion vector.

The image reconstruction process compensates for image distortions in the opposite direction to the respective distortions vector:

a) X-axis compensation is done by selecting relevant pixels from the middle of the captured line, wherein the selection computed in sub-pixel accuracy.

b) Y-axis compensation is done by changing line to line distance at sub-pixel resolution by changing the line offset.

c) Z-axis (yaw) compensation rotates the image in opposite direction to distortion rotational vector.

Step **270**: performing digital zooming.

Optionally, post-capturing image processing unit **160** performs digital zooming, as needed, using binning and/or skipping.

Step **280**: performing digital image stabilization.

Optionally, digital image stabilization unit **190** performs fine digital image stabilization. For example, digital image stabilization unit **190** performs frame-to-frame correlation by computing motional vectors between identified correlated elements in the current image frame and corresponding elements in a previously transmitted frame. Compensate for the computed motion in the opposite direction to yield the final IROI in the form of an image frame.

Step **290**: transmit the final IROI.

Transmit the final IROI to a predetermined to a video receiving unit, typically a remote video receiving unit.

Step **295**: determine if finished to acquire image frames.

if finished to acquire image frames, exit.

Else, go to step **210**.

The invention being thus described in terms of embodiments and examples, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the claims.

What is claimed is:

1. In a computerized camera system mounted on a moving platform, the system including a camera having one or more image sensor arrays, wherein said camera acquires consecutively, in real time, a plurality of image frames including images of the environment viewed from within the field of view of said camera, a method for compensating for image distortions in said acquired image frames, said image distortions formed by motion of said camera during and in between image acquisitions, the method comprising the steps of:

a) providing camera maneuvering signals;

b) providing one or more sensors for detecting said motion of said camera;

c) computing the aggregated motion vector of said camera, thereby determining the pre acquisition image distortion caused by said aggregated motion vector of said camera;

d) compensating for said determined pre acquisition image distortion by a magnitude equal to the magnitude of said aggregated motion vector, in a direction opposite to the direction of said aggregated motion vector; and

e) acquiring an image frame.

2. The method as in claim **1**, wherein said platform is an air born vehicle.

3. The method as in claim **2**, wherein said maneuvering commands are selected from the group consisting of pan and tilt commands.

4. The method as in claim **1**, wherein said camera maneuvering signals are maneuvering commands as provided by the steering control of said camera.

5. The method as in claim **1**, wherein said one or more sensors is a displacement sensor for sensing changes in spatial position.

6. The method as in claim **5**, wherein said displacement sensor is an angular rate sensor, a gyroscope sensor, a rate gyroscope sensor or a smart inertial navigation system unit.

7. The method as in claim **1** further comprising the steps of:

f) providing an environmental region of interest within said environment viewed from within said field of view of said camera; and

g) determining the array of pixels being a portion of said one or more image sensor arrays acquiring the image of said environmental region of interest and thereby obtaining an image region of interest,

wherein said compensating for said determined pre acquisition image distortion is performed on said image region of interest.

8. The method as in claim **7**, wherein the resolution of said acquired image frame is larger than the resolution of said image region of interest and said final image region of interest.

9. The method as in claim **7**, wherein said camera system further includes a motorized mechanical gimbal to extend dynamic range by providing said camera with an additional degree of freedom, and wherein said method further includes the step of:

h) activating said motorized mechanical gimbal to maintain the central pixel of said image region of interest, representing the center of said environmental region of interest, within a distance less than a predefined threshold value from the center of said image sensor array.

10. The method as in claim **9**, wherein said motorized mechanical gimbal uses a pulse width modulation, to control motor force and speed.

11. The method as in claim **7**, wherein said camera system further includes a motorized mechanical gimbal for providing

said camera with an additional degree of freedom, and wherein said method further includes the steps of:

h) computing the distance of each edge of said image region of interest from the respective edge of said image sensor array; and

i) activating said motorized mechanical gimbal to maintain each of said edges of said image region of interest at a distance less than a predefined threshold value from said respective edge of said image sensor array.

12. The method as in claim **11**, wherein said computing of said distance of each of said edges of said image region of interest from said respective edge of said image sensor array, uses a hysteresis function.

13. The method as in claim **12**, wherein the hysteresis values of said hysteresis function are calculated as a function of zoom and motion changes prediction.

14. The method as in claim **7**, wherein the resolution of said acquired image frame is increased using digital zooming methods.

15. The method as in claim **7** further comprising the steps of:

h) determining the post acquisition image distortion caused by said detected motion of said camera from the instant of said issuing of said acquisition command for acquiring said captured image frame until the actual acquisition of said captured image frame; and

i) compensating for said determined post acquisition image distortion by a magnitude equal to the magnitude of said aggregated motion vector, in a direction opposite to the direction of said aggregated motion vector, wherein said compensating for said determined post acquisition image distortion is applied to said image region of interest, whereby creating a final image region of interest.

16. The method as in claim **15** further comprising the steps of:

j) padding said image region of interest with a predefined margin, before said determining said post acquisition image distortion; and

k) cropping said image region of interest to remove said margin, after said compensating for said determined post acquisition image distortion, before forming said final image region of interest.

17. The method as in claim **15** further comprising the steps of:

j) providing a zooming mechanism;

k) providing a zoom request including zoom parameters; and

l) computing said final image region with said parameters of said zoom request.

18. The method as in claim **17**, wherein said zooming mechanism is an optical zoom.

19. The method as in claim **17**, wherein said zooming mechanism is an electronic zoom.

20. The method as in claim **17**, wherein said zooming mechanism is a combination of optical zoom and electronic zoom.

21. The method as in claim **15**, wherein said final image region of interest is transmitted to a video receiving unit.

22. The method as in claim **21**, wherein said video receiving unit is a remote video receiving unit.

23. The method as in claim **7** or **8**, wherein said camera includes a rolling shutter having a rolling shutter image distortion, and wherein said method further includes the steps of:

a) determining said rolling shutter image distortion; and

b) compensating for said determined rolling shutter image distortion in an opposite direction to the direction of said rolling shutter image distortion for each line or pixel in said image region of interest.

24. The method as in claim **23**, wherein said determining said rolling shutter image distortion and said compensating for said determined rolling shutter image distortion are performed in line, pixel or sub-pixel resolution.

25. The method as in claim **23**, wherein said compensating for said determined rolling shutter image distortion is performed in the X-axis by line shifts to the opposite direction of said rolling shutter motion during the image acquisition scan.

26. The method as in claim **23**, wherein said compensating for said determined rolling shutter image distortion is performed in the Y-axis by calculating and changing the line to line distances.

27. The method as in claim **23**, wherein said image region of interest is the whole of said one or more image sensor arrays.

28. The method as in claim **23**, wherein the resolution of said acquired image frame is larger than the resolution of said image region of interest and said final image region of interest.

29. The method as in claim **23**, wherein the resolution of said acquired image frame is increased using digital zooming methods.

30. The method as in claim **23** further comprising the steps of:

c) providing a digital image stabilization unit;

d) determining residual image distortions; and

e) compensating for said residual image distortions.

31. The method as in claim **23**, wherein said camera system further includes a motorized mechanical gimbal to extend dynamic range by providing said camera with an additional degree of freedom, and wherein said method further includes the step of:

c) activating said motorized mechanical gimbal to maintain the central pixel of said image region of interest, representing the center of said environmental region of interest, within a distance less than a predefined threshold value from the center of said image sensor array.

32. The method as in claim **23**, wherein said camera system further includes a motorized mechanical gimbal for providing said camera with an additional degree of freedom, and wherein said method further includes the steps of:

c) computing the distance of each edge of said image region of interest from the respective edge of said image sensor array; and

d) activating said motorized mechanical gimbal to maintain each of said edges of said image region of interest at a distance less than a predefined threshold value from said respective edge of said image sensor array.

33. The method as in claim **15** further comprising the steps of:

j) providing a digital image stabilization unit;

k) determining residual image distortions; and

l) compensating for said residual image distortions.

34. The method as in claim **33**, wherein said determining of residual image distortions includes computing the correlation between a previously computed final image region of interest and the currently computed final image region of interest.

35. The method as in claim **15**, wherein the resolution of said acquired image frame is larger than the resolution of said image region of interest and said final image region of interest.

36. The method as in claim **15**, wherein the resolution of said acquired image frame is increased using digital zooming methods.

37. The method as in claim **15**, wherein said camera system further includes a motorized mechanical gimbal to extend dynamic range by providing said camera with an additional degree of freedom, and wherein said method further includes the step of:

j) activating said motorized mechanical gimbal to maintain the central pixel of said image region of interest, representing the center of said environmental region of interest, within a distance less than a predefined threshold value from the center of said image sensor array.

38. The method as in claim **15**, wherein said camera system further includes a motorized mechanical gimbal for providing said camera with an additional degree of freedom, and wherein said method further includes the steps of:

j) computing the distance of each edge of said image region of interest from the respective edge of said image sensor array; and

k) activating said motorized mechanical gimbal to maintain each of said edges of said image region of interest at a distance less than a predefined threshold value from said respective edge of said image sensor array.

39. The method as in claim **1**, wherein the resolution of said acquired image frame is increased using digital zooming methods.

40. A computerized camera system mounted on a moving platform for compensating for image distortions in acquired image frames, the system including a camera having one or more image sensor arrays, wherein said camera acquires consecutively, in real time, a plurality of image frames including images of environment viewed from within a field of view of said camera, the camera system comprising:

a) a coordinate offset calculation unit;

b) a camera steering control;

c) a displacement sensor;

d) an image sensor configuration control unit; and

e) a video timing unit,

wherein said video timing unit determines the frame acquisition rate of said camera and wherein said video timing unit begins a frame acquisition cycle having a pre acquisition portion and a post acquisition portion;

wherein said camera steering control provides tilt and/or pan motional data of said camera;

wherein said displacement sensor senses said camera motion in space;

wherein said coordinate offset calculation unit continuously aggregates said sensed motions of said camera and thereby determining an pre acquisition aggregated motion vector;

wherein said image sensor configuration control unit determines the pre acquisition image distortion caused by said pre acquisition aggregated motion vector; and

wherein said image sensor configuration control unit compensates for said determined pre acquisition image distortion by a magnitude equal to the magnitude of said pre acquisition aggregated motion vector, in a direction opposite to the direction of said pre acquisition aggregated motion vector, whereby creating a pre acquisition compensated image frame.

41. The camera systems as in claim **40** further comprising:

f) a computation unit; and

g) a post-capturing image processing unit,

wherein said coordinate offset calculation unit and said image sensor configuration control unit provide said computation unit with timing on motion data;

wherein said computation unit continuously aggregates said sensed motions of said camera from the instant of issuing of a command for acquiring an image frame until the actual acquisition of the image frame and thereby determining a post acquisition aggregated motion vector;

wherein said post-capturing image processing unit determines the post acquisition image distortion caused by said post acquisition aggregated motion vector; and

wherein said post-capturing image processing unit compensates for said determined post acquisition image distortion by a magnitude equal to the magnitude of said post acquisition aggregated motion vector, in a direction opposite to the direction of said post acquisition aggregated motion vector, whereby creating a post acquisition compensated image frame.

42. The camera systems as in claim **41** further comprising a digital image stabilization unit, wherein said digital image stabilization unit performs final digital image stabilization and small jitter correction.

43. The camera system as in as in claim **41** further comprising a motorized gimbaled device, wherein said motorized gimbaled device provides said camera with an additional degree of freedom; and wherein said motorized gimbaled device facilitates maintaining a pre selected environmental region of interest within said field of view of said camera.

44. The camera systems as in claim **40** further comprising a mechanism for adjusting the zoom of said camera.

45. The camera systems as in claim **40** further comprising a motorized gimbaled device, wherein said motorized gimbaled device provides said camera with an additional degree of freedom; and wherein said motorized gimbaled device facilitates maintaining a pre selected environmental region of interest within said field of view of said camera.

46. The camera system of claim **40** further comprising a remote video receiving unit.

* * * * *

IAI Unveils the Ghost – a Miniature UAV For Special Operations

By **Tamir Eshel** - Aug 8, 2011

The twin rotors create adequate lift within a relatively small diameter (0.75 cm / 2.46 ft), enabling the Ghost to navigate safely near obstacles, enter through windows and hover inside built-up areas or penetrate dense vegetation. Photo: IAI

IAI Malat is unveiling the Ghost and Mini Panther, two new vertical take-off and landing miniature unmanned vehicles currently undergoing test flights, both are expected to be ready for marketing soon. Both vehicles will be displayed at the AUVSI exhibition in Washington next week. The Ghost, 145 cm long (4.76 ft) vehicle designed specifically to support special operations units and and company level infantry operations. Ghost was optimized for operation in built-up areas, rugged terrain and dense brushes, typically of the terrain in South Lebanon. As an electrically powered, twin-rotor mini-UAV Ghost is capable of operating on missions of about 30 minutes.

The twin rotors create adequate lift within a relatively small diameter (0.75 cm / 2.46 ft), enabling the Ghost to navigate safely near obstacles in complex urban terrain including inside buildings. Photo: IAI

Its aerodynamic configuration and twin-rotor propulsion system contributes to high stability in hovering mode, and effective station keeping even in strong sidewinds and gusts. The twin rotors create adequate lift within a relatively small diameter (0.75 cm / 2.46 ft), enabling the Ghost to

navigate safely near obstacles, enter through windows and hover inside built-up areas or penetrate dense vegetation. The twin rotors are powered by two separate, synchronized electrical motors, offering some redundancy in case one motor is disabled. In fact, the Ghost designers expect the final version to be able to recover back to safe ground using a single motor. The Ghost can travel at speed from 35 knots (64 km/h) to zero.

The stealthy Ghost operates quietly in day or night. Its hovering capability provides the user flexible view of the area of interest, including a unique horizontal visibility, unavailable with other flying sensors. The Ghost weighs only four kilograms (9 lb.) and comes packed in a suitcase carried by a single soldier. A system is comprising two vehicles, spare batteries and control station employing a laptop computer. Ghost can carry a payload weighing up to 600 gr (21 oz). The current payload includes the stabilized daylight MicroCam D from Nextvision, An IR night capable sensor is also available at a compatible weight; other payloads are also considered by IAI for future missions.

The twin rotors create adequate lift within a relatively small diameter (0.75 cm / 2.46 ft), enabling the Ghost to navigate safely near obstacles, enter through windows and hover inside built-up areas or penetrate dense vegetation. Photo: IAI

To support indoor operations the EO system is equipped with mapping capability, automatically measuring indoor space perimeters, to enable the Ghost safe entry and maneuvering inside a room.

Mini Panther is another electrically powered VTOL UAV developed at IAI. Mini Panther weighs 12 kg and is configured for backpack operation by a single infantryman. Its mission endurance can reach 90 minutes, carrying a payload weight of up to one kilogram. While capable of automatically takeoff and landing in vertical mode, Mini Panther performs its mission mostly in forward flight, a mode consuming less power, enabling extended mission endurance.

The Ghost, 145 cm long (4.76 ft) vehicle designed specifically to support special operations and infantry operations in built-up areas, rugged terrain or the dense brushes of South Lebanon, is an electrically powered, twin-rotor mini-UAV capable of operating on missions of about 30 minutes. Photo: IAI

In 2007 Defense Update reported on an earlier design called 'DP-6 Whisper', developed by Michael W Piasecki, founder of Dragonfly Pictures. The Whisper had similar attributes such as acoustic stealth. The Whisper was also proposed to deploy as a persistent airborne tethered sensor boosting perimeter security around Forward Operating Bases, tethering power from a battery or generator on the ground.

Drones > Drone equipment > Drone camera > **NextVision Stabilized Systems**

NextVision STABILIZED SYSTEMS LTD

Products

Aerial photography camera MicroCam-D

for drone

Add to favorites

Sold by:

NextVision Stabilized Systems

United Kingdom

See contact information

Go to the NextVision Stabilized Systems website for more information

CHARACTERISTICS

Type
aerial photography

Applications
for drone

DESCRIPTION

At 130 grams [4.6 oz], MicroCam-D is the lightest cameras NextVision offers, and provides an entry-level stabilized camera for day time operation.Zoom : x4.4 + x2 digital (total x8.8) HFOV : 20.7° WFOV – 4.7° NFOV – 2.3° DFOVPitch FOR: -45° to +90°Roll FOR: -180° to +180°Weight : 130 grams [4.6 ozDimensions : Diameter=70mm [2.8 x Height=80mm [3.1

Go to the NextVision Stabilized Systems website for more information

BUYERS WHO LIKED THIS PRODUCT ALSO LIKED

OFIL SYSTEMS

SPARK OPTICAL EMISSION CAMERA
DAYCOR® MICROM HD

- UV
- for drone
- high-resolution

OFIL SYSTEMS

SPARK OPTICAL EMISSION CAMERA
DAYCOR® ROMPACT

- monitoring
- UV
- for drone

draganfly INNOVATIONS INC

DRONE DETECTION CAMERA SYSTEM

- for drone
- high-resolution

AARONIA AG
WWW.AARONIA.DE

DRONE DETECTION CAMERA
PTZ

- for drone
- with night vision

See other similar products

OTHER NEXTVISION STABILIZED SYSTEMS PRODUCTS

CAMERAS

AERIAL PHOTOGRAPHY CAMERA
MICROCAM-D2

for drone

AERIAL PHOTOGRAPHY CAMERA
HAWKEYE

for drone

AERIAL PHOTOGRAPHY CAMERA

COLIBRI

- for drone

AERIAL PHOTOGRAPHY CAMERA

ORION

- for drone
- high-resolution

AERIAL PHOTOGRAPHY CAMERA
NIGHTHAWK

- thermal
- for drone

See all NextVision Stabilized Systems products ›

Related Searches

Drone camera system

*Prices are pre tax They exclude delivery charges and customs duties and do not include additional charges for installation or activation options Prices are indicative only and may vary by country, with changes to the cost of raw materials and exchange rates.

ITT

8/99

Fujinon Broadcast ENG series.

How far do you want to go? Fujinon A36 x 10.5 and A36 x 14.5 lenses.

The A36x10.5 and the A36x14.5 lenses are a perfect choice when your application requires long focal length, light weight and portability.

The weight of these lenses is less than 4.6 kg. Nevertheless they offer the highest magnification and focal length available in the ENG market. Take the A36x14.5. Even without the extender, its focal length reaches 520 mm; for twice that simply activate the extender.

Unprecedented ramping characteristics, Aspheric Technology, Internal Focusing and the digital full-servo drive unit round off the performance of the A36x10.5 and A36x14.5 lenses.

The utilization of digital circuitry has made functions like Quickzoom, Auto-cruising zoom and one shot memory possible. The zoom characteristic and the maximum zoom speed can be selected by the camera operator according to his personal needs. These new functions increase the operational comfort to a level which is not available with any other long focal length lens in the world.

The Fujinon A36x lenses are marvels of optical engineering and no other lens comes close in performance or features.

Fujinon. To see more is to know more.

A36x10.5

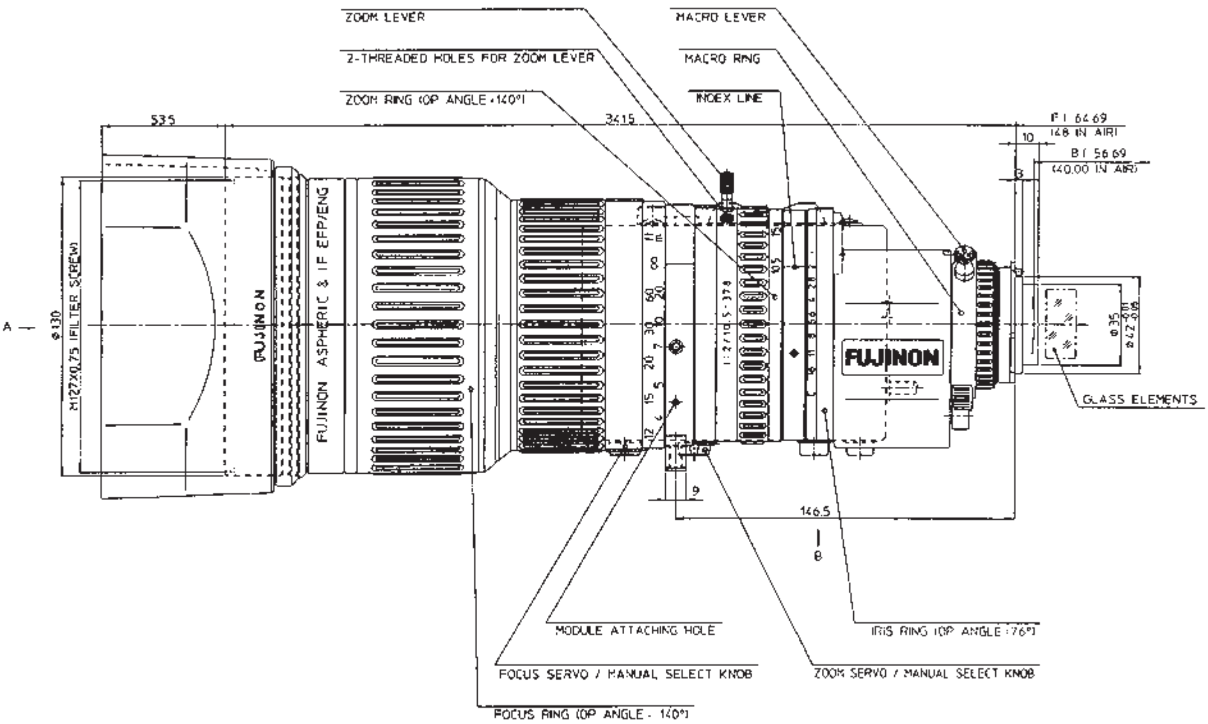
Specifications/Lens		A36x10.5 ERD	A 36x14.5 ERD
Zoom ratio		36x	36x
Extender		2x	2x
Focal length w/o extender		10.5 – 378 mm	14.5 – 520 mm
Focal length w/ extender		21 – 756 mm	29 – 1040 mm
Maximum relative aperture		F2.0 (10.5 – 222 mm) F3.4 (378 mm)	F2.7 (14.5 – 305 mm) F4.6 (520 mm)
Angular field of view (Hor. x Vert. in °)	4:3 Aspect ratio (8.8x6.6 mm)	10.5 mm: 45°28' x 34°54' 378 mm: 1°20' x 1°00'	14.5 mm: 33°46' x 25°39' 520 mm: 0°58' x 0°44'
	16:9 Aspect ratio (9.59x5.39 mm)	10.5 mm: 49°05' x 28°47' 378 mm: 1°27' x 0°49'	14.5 mm: 36°36' x 21°03' 520 mm: 1°03' x 0°36'
Minimum Object Distance M.O.D.		2.2 m	2.2 m
Object dimensions at M.O.D. (Hor. x Vert. in mm)	4:3 Aspect ratio (8.8x6.6 mm)	10.5 mm: 1,726 x 1,295 mm 378 mm: 48 x 36 mm	14.5 mm: 1,250 x 938 mm 520 mm: 35 x 26 mm
	16:9 Aspect ratio (9.59x5.39 mm)	10.5 mm: 1,881 x 1,058 mm 378 mm: 52 x 29 mm	14.5 mm: 1,362 x 766 mm 520 mm: 38 x 21 mm
Length		341.5 mm	363.3 mm
Macro		yes	yes
Filter Thread		ø 127 mm, P = 0.75	ø 127 mm, P = 0.75
Weight (without lens hood)		4.5 kg	4.58 kg
Operating system		ERD	ERD
Memo		AT 2, Inner Focus, DIGI POWER ENG	AT 2, Inner Focus, DIGI POWER ENG

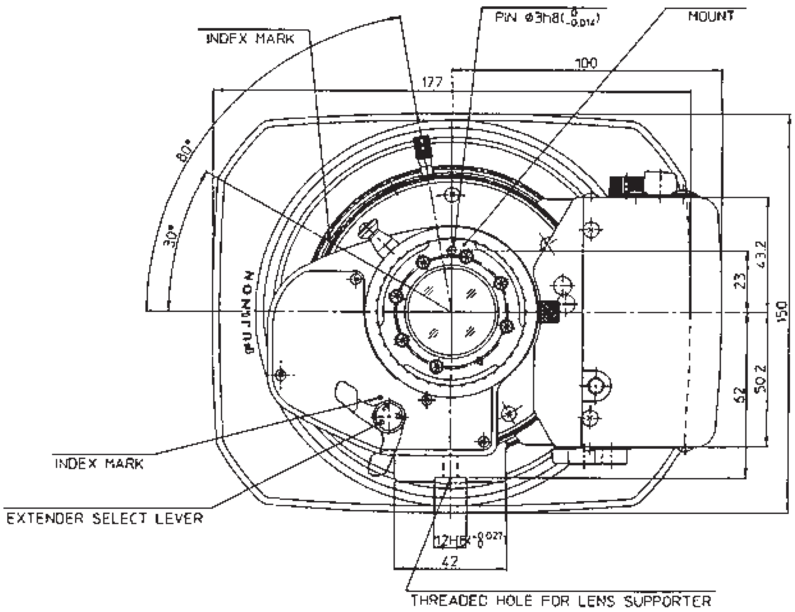
Specifications are subject to change without notice.

FUJINON

FUJINON (EUROPE) GMBH HALSKESTRASSE 4, 47877 WILLICH, GERMANY, TEL.: +49/(0)2154/924-0, FAX: +49/(0)2154/924-290, E-MAIL: Fujinon@fujinon.de
FUJI PHOTO OPTICAL CO., LTD. 1-324 UETAKE, OMIYA CITY, SAITAMA 330-8624, JAPAN, TEL.: +81/(0)48/668/2153, FAX: +81/(0)48/651/8517, http://www.fujinon.co.jp/

Outline drawings.
(A36 x 10.5 BERD)





ACCESSORIES A36 x 10.5/14.5	
Filters	
EFL-127 UV	UV
EFL-127 SL	Skylight
EFL-127 N2	Neutral density 2
EFL-127 N4	Neutral density 4
EFL-127 N8	Neutral density 8
EFL-127 CS	Cross screen
EFL-127 SN	Snow cross
EFL-127 SU	Sunny cross
EFL-127 SF	Soft focus
EFL-127 PL	Polarizing

Annotations: Specifications are subject to change without notice. For more detailed information and for additional accessories, please refer to the general catalogue.

Hi! Sign in Sell Watchlist My eBay

Search for anything All Categories

Back to home page | Listed in category: Cameras & Photo > Lenses & Filters > Lenses

People who viewed this item also viewed

Fujinon A36X10.5 BERD-R28. SUPER TELEPHOTO ZOOM LENS. BROADCAST LENS
$4,800.00
Free shipping

Fujinon HD HA13x4.
B4 Broadcast lens
$7,000.00
+ $100.00 shipping

Have one to sell? Sell now

Fujinon A36X14.5 BERD-R28

Condition: Used

Price: US $10,995.00
$528 for 24 months with PayPal Credit*

Buy It Now
Add to cart

Best Offer:
Make Offer
Add to Watchlist

30-day returns | Free shipping | Ships from United States

Shipping: Free 3 day shipping
Get it by Thu. Mar. 25 | See details
tem location: Broken Arrow, Oklahoma, Un ted States
Ships to: United States See exclusions

Payments:
PayPal CREDIT
*$528 for 24 months. Minimum purchase required. |
See terms and apply now

Earn up to 5x points when you use your eBay Mastercard®. Learn more

Returns: 30 day returns. Buyer pays for return shipping | See details

Shop with
eBay
Get th
your m

Seller infor
alliedbroadc
100% Positive

Save this
Contact selle
Visit store
See other ite

Related sponsored items

Auto Focus Macro Lens

K&F Concept adapter for

Canon EF-EOS R Control

M42 Pentax screw Metal

MAMIYA Medium Format

HD 1080P D

Lightweight UAS Demand Accelerates Development of Lightweight Payloads

First responders and Homeland Security forces worldwide are today investigating the use of UAS in the HLS arena.

The 2013 EU Roadmap, for example, illustrates the plan to engage UAS in Civil Airspace. According to the roadmap, the goal is to achieve a capability for remotely piloted aircraft systems to fly in general airspace — with some restrictions — by 2016, and to achieve full operational capability by 2020.

HLS forces and first responders that would like to acquire UAS are in need of lightweight systems that can be deployed and launched within minutes, are capable of providing them with intelligence and reconnaissance capability both day and night, and include tracking of moving targets and laser pointers.

This is in addition to the fact that the HLS forces at field are already wearing various kinds of weapons, ballistic vests, etc., leading the UAS industry to develop high end lightweight UAS systems.

Thus, the requirement for the downscaling of UAS and payloads has become a millstone for UAS companies worldwide. A company that cannot keep up with this development can find itself out of business tomorrow.

UAS minimization which is reaching 90% or more from earlier versions of UAS systems, and the demand for lightweight systems that has the same technological capability of the earlier and heavier UAS systems, has created a real revolution in the Mini and Micro UAS systems segment.

R&D budgets of hundreds of million dollars are invested in the minimization and creation of new payloads with the ability for day and night observation and laser pointers – all in one payload.

Recently, Aerovironment introduced a new version of the WASP UAS system that includes the mantis payload. This payload has a day and night capability and a laser pointer – all of it weighing 275 grams. In Israel, different payloads companies such as NextVision are offering payloads in similar weights (the MicroCam D by Nextivision weights only 100 grams.)

The enhanced requirements from UAS led to a significant leap forward in the technology and approach for solving the problems of stabilization and tracking in these lightweight payloads. The old payloads which weighted several kilograms have gone through some major changes and developments and weigh a mere hundred grams today.

Modifications were made in both the mechanical and stabilization aspects. In the mechanical aspect the use of metal was converted to the use of composite materials. In the stabilization aspect, there is a transition from electro-mechanical stabilization of the mounting system, to electronic stabilization on the sensor.

The progress in the computing components according to Moore's law gave us the possibility to calculate the algorithms achieving the tremendous speeds required for stabilization.

The requirement for a fully autonomous UAS that can face obstacles and operate independently in high risk missions demanded enhanced performance and different payloads Therefore we are seeing today not only electro-optical payloads, but also wide spectral payloads, EW payloads, payloads that enable detection and alarm of obstacles and threats.

In the near future we will see smaller payloads achieved within radar laser and thermal systems We are talking about payloads that would not exceed 100 grams. These developments are causing a change in the operational concept of UAS. We may soon see tiny UAS operating in the urban arena, giving increased situational awareness for both indoor activities and the outdoor area. In open fields we will see UAS flying in high endurance enabling constant situational awareness pic tures of the city; and swarms of fully autonomous UAS that are able to complete their mission independently and tackle any mission obstacles by themselves.

These developments will be made possible largely due to large R&D budgets with increased funds aimed at reducing the weight of the HLS forces systems.

Article by Michael Armon, originally published in IHLS. Mr. Michael Armon is the CEO of Innocon

Source: IHLS

Posted in Payloads on February 13, 2013 by The Editor. Leave a comment

← SOUTH KOREA MILITARY CONSIDERS USING UNMANNED ATTACK HELICOPTERS AGAINST NORTH

INSITU TAKES BACK SOCOM ISR SERVICES WORK FROM AAI →

LEAVE A REPLY

Your email address will not be published. Required fields are marked *

Comment

Name *

Email *

Website

POST COMMENT

SEARCH BY CATEGORY

Select Category

FOLLOW

NextVision
Stabilized Systems Ltd.

MicroCam-D

The world first
<100gr gyro-stabilized payload

```
Weight         : 99 gr
Zoom           : x8.8
Stabilization  : <100uRad
```

| Company | Products | Technology | Gallery | Video | Contact Us |

COMPANY PROFILE

NextVision is a privately owned company focusing on development and production of Electro-Optical stabilized payload and solid state digital cameras for day and night observation.

NextVision's stabilized cameras provide multiple advantageous to its users:
- The weight of the cameras is significantly low
- The size of the cameras is considerably small
- The cameras consume little power
- The cameras have excellent reliability
- The cameras provide significant cost advantage

The lucrative advantageous of NextVision's stabilized cameras make them the preferred choice for various applications and markets.

NextVision's products are successfully used by our customers in various applications: UAVs, balloon observation systems, imaging seekers, target acquisition & reconnaissance binoculars, high accuracy sights, covert cameras and others.

NEXTVISION NEWS

------------------- NEWS -------------------

APPLICATIONS

Industrial
Law Enforcement
Search and Rescue (SAR)
Border and Maritime Patrol
Surveillance and Reconnaissance
Entertainment & News
Sports

of the scene in the image or showing a smaller portion of the scene in greater detail. (Ex. 1001, ’408 patent at 1:40–45.)

28. Traditionally, zoom capability was provided using mechanical optical zooming, moving lens elements relative to each other to change the focal length, and thus the magnification of the lens. (Ex. 1001, ’408 patent at 1:45–47.) Mechanical optical zoom lenses are generally more expensive and larger than fixed focal length lenses. (Ex. 1001, ’408 patent at 1:47–49.) Another approach to zoom is digital zooming, where a digital processor provides a magnification effect by cropping the image from a fixed focal length lens and interpolating between the pixels to create “a magnified but lower-resolution image.” (Ex. 1001, ’408 patent at 1:54.)

29. An alternative to both mechanical and traditional digital zoom is described in the ’408 patent. In the ’408 patent, an improved digital zoom is provided using a “dual-aperture” configuration. (Ex. 1001, ’408 patent at 3:30–32.) As shown in Figure 1B of the ’408 patent, two compact cameras, one with a wide lens and one with a tele lens are located next to each other:

non-technical dictionary definitions of "telephoto" such as "of, relating to, or being a photographic lens or lens system used to produce a large image of a distant object." (Ex. 2014, American Heritage College Dictionary at 1395.) I note that Dr. Sasián does not argue that Golan teaches the use of a lens that satisfies the limitation requiring a TTL to EFL ratio smaller than 1. (Ex. 1003, Sasián Declaration, ¶¶ 100–107.

51. Golan also does not directly specify the dimensions of its image sensors or the weights of its components. However, Golan does provide information that would tell a POSITA what size cameras its contemplated using to achieve its goals of "light weight" and low cost. Specifically, Golan describes using a digital sensor with approximately 5 megapixels. (Ex. 1005, Golan, ¶ 4.)

52. To a POSITA that pixel count of 5 megapixels identifies the likely sensor size. The digital sensor accounts for a substantial fraction of the cost of a digital camera, and that cost depends strongly on the area of the silicon wafer occupied by the sensor when it is made. There are practical limits to how small sensor pixels can be made, due to limitations in fabrication technology and limitations in how finely image features can be resolved on the image plane. But, there are also limits to how large sensor pixels are made. If a customer is

going to incur the cost of a larger sensor, they are likely going to want the benefits of increasing the pixel count.

53. As shown in the following table, published in 2014, the sizes of pixels in available digital sensors remained approximately constant (between 1.4 and 2 microns) with varying sensor size, with the pixel count scaling directly with the sensor area. It is only in the largest, most expensive sensors, having pixel counts in excess of 10 megapixels, that pixels are larger:

TABLE 1.1 Comparison of Camera Formats

(a) Miniature Camera Modules, Digital Cameras, and Film Cameras[a]

Inch-Format	Horizontal (mm)	Vertical (mm)	Diagonal (mm)	Area (mm²)	Megapixels	Minimum Pixel (mm)	Maximum Pixel (mm)	Linear Scale (35 mm ref) (%)	Area Scale (35 mm ref) (%)	Typical Minimum f/number	EFL	Entrance Pupil Diameter
Miniature Camera Modules												
1/6	2.32	1.74	2.90	4.04	1.3–2	0.0014	0.0017	7	0.4	2	2.28	1.14
1/5	2.80	2.10	3.50	5.88	2–3	0.0014	0.0017	8	0.7	2	2.75	1.37
1/4	3.60	2.70	4.50	9.72	3–5	0.0014	0.0017	10	1.1	2.4	3.53	1.47
1/3	4.80	3.60	6.00	17.28	5–8	0.0014	0.0017	14	1.9	2.8	4.71	1.68
Digital Still Cameras												
1/2.3	6.08	4.56	7.60	27.72	12–16.6	0.0015	0.0022	18	3.1	2.8	6.0	2.1
1/2	6.40	4.80	8.00	30.72	16	0.0014	0.0014	18	3.4	2.4	6.3	2.6
1/1.7	7.44	5.58	9.30	41.52	10–12	0.0019	0.002	21	4.6	2	7.3	3.6
1	13.20	8.80	15.86	116.16	14.2	0.0029	0.0029	37	13	2	12.5	6.2
APS-C	23.60	15.80	28.40	372.88	12.2–24.7	0.0039	0.0055	66	43	2	22.3	11.1
FULL	36.00	24.00	43.27	864.00	18.1–24.7	0.0059	0.0069	100	100	1.4	34.0	24.3
Film Cameras												
Disc	11.0	8.0	13.6	88				31	10	2	10.7	5.3
APS-H	30.2	16.7	34.5	504				80	64	2	27.1	13.5
35 mm	36.0	24.0	43.3	864				100	100	1.4	34.0	24.3
6 × 6 cm	60.0	60.0	84.9	3600				196	385	2.8	66.6	23.8
4 × 5 in.	127.0	101.6	162.6	12903				376	1413	4.5	127.6	28.4

(Ex. 2007, Galstain at 4.)

54. Based on this table, POSITA in 2009, the earliest priority date for Golan, or in 2013, would have understood that a 5 megapixel sensor was likely to be a 1/4-inch or 1/3-inch sensor, with a diagonal dimension of 4.5 mm or

6.0 mm. Dr. Sasián appears to agree. During his deposition, he testified that he believes the 5 megapixel sensor described in Golan would have a diagonal of 6.0 mm and semidiagonal of 3.0 mm. (Ex. 2005, Sasián Deposition at 46:10–48:3.) Cameras using sensors of these sizes are considered miniature cameras. (Ex. 2007, Galstain at 4.) As a result, a POSITA reading Golan would recognize that its "light weight" and low cost electronic zoom invention contemplates the use of miniature camera modules.

B. Kawamura

55. Kawamura was published in 1983 as Japanese Patent Application Publication S58-62609. (Ex. 1007, Kawamura at 1.) It was filed in 1981. (Ex. 1007, Kawamura at 1.) The applicant was Asahi Optical Co., a Japanese camera manufacturer that sold cameras under the Pentax brand. (Ex. 1007, Kawamura at 1.)

56. Kawamura describes "a lens of a focal length of about 200 mm for a screen size of 6x7" and provides four examples of such 200 mm focal length lenses. (Ex. 1007, Kawamura at 1, 3–5.) It also refers to the possibility of "a focal length of about 150 mm for a screen size of 4.5x6," but it does not provide any examples of such a lens. (Ex. 1007, Kawamura at 1.)

57. The Pentax 6x7 was a medium format SLR camera utilizing 120 or 220 roll film.[1] The term "medium format" refers to film sizes smaller than the "large format" film used in early studio cameras, but larger than the 35 mm and smaller films that were once ubiquitous. The 120 film format is over a century old, having been introduced for use in the Eastman Kodak "Brownie" camera in 1901.[2] The nominal width images on 120 (and 220) film is 56 mm, substantially larger than the 24 mm width of images on "35 mm" 135 format film.[3] A 6x7 image has a nominal size on the film of 56 mm x 67 mm, and a 4.5x6 image has a nominal size on the film of 56 mm x 41.5 mm.[4] Therefore, the numbers in "6x7" and "4.5x6" correspond to the approximate film dimensions in centimeters. (Ex. 2005, Sasián Deposition at 42:20–43:20.)

58. The Kawamura lens has "a brightness of about 1:4." (Ex. 1007, Kawamura at 1.) Each of the examples in Kawamura actually have a brightness ratio of 1:4.1. (Ex. 1007, Kawamura at 3–5.) This brightness ratio is another way of expressing what is commonly called the "f-number."[5] So, the Kawamura

---

[1] https://en.wikipedia.org/wiki/Pentax_6%C3%977
[2] https://en.wikipedia.org/wiki/Brownie_(camera)
[3] https://en.wikipedia.org/wiki/120_film, https://en.wikipedia.org/wiki/135_film
[4] https://en.wikipedia.org/wiki/120_film
[5] https://www.kenrockwell.com/tech/lens-specifications.htm ("f/numbers are usually expressed as fractions with a slash, like f/5.6, when writing them

60. The Pentax 6x7 camera body (without lens) was 184 mm (about 7.25 inches) wide and weighed 1.29 kg (almost 3 pounds).[7] A lens added further weight. As this photo shows, the manufacturer made a hand grip to assist the user in holding and controlling the heavy camera.

[7] http://camera-wiki.org/wiki/Pentax_67

61. The following photo shows the Pentax 6x7 camera, together with an Asahi 200 mm, 1:4 brightness lens of the general type described in Kawamura[8]:

62. The following photos from an eBay listing shows the same Asahi 1:4/200 6x7 lens and better illustrate its shape and dimensions[9]:

[8] http://camera-wiki.org/wiki/Pentax_67
[9] https://www.ebay.com/p/126837639


1:4/200
8263349
ASAHI OPT. CO.

63. According to this eBay listing, the lens has a weight of 8.88 oz.[10] This is not surprising given the multiple large glass elements and the need for a large barrel to hold them. While the Asahi lens shown in these photos may not have exactly the same design as described in the Kawamura patent, it is of the same general class of lenses. This further confirms that a camera using a lens of the type described in Kawamura would weigh multiple pounds.

64. The following photo shows a Pentax 4.5x6 camera.[11] Note that the lens in this photo is a 45 mm focal length lens, much shorter than the 150 mm lens mentioned by Kawamura. While the 4.5x6 camera is narrower than its 6x7 counterpart, it is still a much larger and heavier camera than more typical 35 mm cameras.

---

[10] https://www.ebay.com/p/126837639
[11] http://camera-wiki.org/wiki/Pentax_645

65. According to Dr. Sasián's Zemax analysis, the four example lenses in Kawamura TTL values between 179 and 188 mm, all greater than 7 inches.[12] This means that any camera with one of these lenses attached would be at least 7 inches long.

66. Unsurprisingly for a lens of this size in that era, the lens elements are made of glass. (Ex. 1007, Kawamura at 2–3.) Also to be expected for a lens from 1981, the lens elements are all spheric, meaning that the front and rear

[12] (Ex. 1003, Sasián Declaration at 62–65.)

IX. OBVIOUSNESS

A. Claim 5 Is Not Obvious over Golan in Combination with Kawamura

73. It is my opinion that a POSITA would not have been motivated to utilize the Kawamura lens designs in the Golan system, either unmodified or scaled to a smaller size.

1. Using Kawamura Unmodified in Golan

74. To the extent that Apple argues that a POSITA would use the Kawamura lenses in Golan without modification, I disagree. As explained above, the goal in Golan was to avoid "heavy and expensive lenses" and to achieve "light weight electronic zoom." (Ex. 1005, Golan, ¶¶ 7–9.) In the context of camera design, the 7-inch Kawamura lenses would have been considered "heavy," both in 1981 when Kawamura was filed and in 2009 on Golan's asserted priority date. Mechanical zoom lenses much lighter than the unscaled Kawamura lenses were commonly available for 35 mm and smaller cameras.

75. This conclusion is further strengthened by the fact that Golan contemplates use of 5 megapixel digital sensors. As explained above, 5 megapixel sensors commonly had dimensions of 2.7 mm x 3.6 mm or 3.6 mm x 4.8 mm, much smaller than the 56 mm x 67 mm film size Kawamura's lenses were designed for. (Ex. 2007, Galstain at 4.) A common 5 megapixel sensor would

cover between 0.25% and 0.46% of the area covered by the film Kawamura was designed for, i.e., it is smaller by a factor of 200x or 400x in area. Using such a massive lens with a tiny 5 megapixel sensor would be extremely unusual and would result in an extremely cropped image of the scene. No POSITA would be motivated to do this.

2. Scaling Kawamura to Use in Golan

76. I also disagree that a POSITA would have been motivated to scale Kawamura for use in Golan. At the time that Golan was written, Kawamura's design was 28 years old. Substantial improvements in computation power, design techniques, materials, and manufacturing techniques meant that lenses made in 2009 or in 2013 were substantially improved in performance and other characteristics over even high-quality lenses designed in 1981.

77. Kawamura's lenses were also designed for a different purpose, with different design constraints, than a lens for the Golan system. As explained above, the 5 megapixel sensor described in Golan would typically have had a diagonal size of 4.5 mm or 6.0 mm. (Ex. 2007, Galstain at 4.) Applying the Pythagorean theorem, a 56 mm x 67 mm rectangle of film has a diagonal size of approximately 87 mm. So, the Kawamura lens would need to be scaled down by a factor of around 14x to 20x in order provide the same field of view

on a 5 megapixel sensor. Dr. Sasián appears to generally agree, as he estimated during his deposition that the Kawamura lens would be scaled by a factor of 10x. (Ex. 2005, Sasián Deposition at 47:24–48:3.)

a. Scaling Lens Designs by a Large Factor Is Not Done in Practice

78. Dr. Sasián's brief discussion of lens scaling suggests that scaling by large factors is routine and would be expected to result in a well-performing lens. (Ex. 1003, Sasián Declaration, ¶ 64.) I disagree. While it is true that from the standpoint of the geometric optics of an ideal lens design, scaling that design will also scale the aberrations of the design and leave many dimensionless properties of the lens design unchanged, that does not does not mean that the resulting design will be practical or useful. There is more to a good lens design than the geometric optics of a lens perfectly fabricated to the design. Scaling a design can dramatically alter the practicality of manufacturing the design and its sensitivity to variations in manufacturing. In addition, the most important performance characteristics for judging a lens design (including parameters such as f-number, field of view, and manufacturing tolerances) will change with the scale of a lens, meaning that scaling a good conventional lens

design to a smaller size will often produce a design that is substantially inferior for its intended purpose to designs that were specifically created to be used as small lenses.

79. Dr. Sasián and his Ph.D. students have acknowledged the impracticality of scaling conventional lens designs to miniature size in their academic writings, as have others in the field, both prior to Golan's filing date and after.

80. For example, Dr. Sasián and his Ph.D. student Dmitry Reshidko wrote in 2015:

> A traditional objective lens ***can not be simply scaled down*** as a lens solution due to fabrication constraints, materials properties, manufacturing process, light diffraction and geometrical aberrations.

(Ex. 2008, Reshidko and Sasián at E216.)

81. In the same paper, Dr. Sasián wrote that "[t]he practically achievable ratio of the total length to the focal length in lenses for mobile cameras is between 1.15 and 1.3 [12]." (Ex. 2007, Reshidko and Sasián at E217.) This further illustrates the difficulties of scaling conventional lenses to miniature size. Otherwise, Dr. Sasián's statement would make no sense. Telephoto lenses with a ratio of the total length to the focal length less than 1.0 were first

achieved in the 1800s and were widely used in film cameras and other applications in the twentieth century.[15] If simple scaling of these conventional lenses would produce practical lenses, then Dr. Sasián would not have written in 2015 that 1.15 was the lowest ratio of the total length to the focal length that was "practically achievable."

82. Dr. Sasián's student Yufeng Yan[16] explained in his Ph.D. dissertation that "that the design approaches and lens constructions are significantly different between a miniature camera lens and a conventional camera lens" and that "if the conventional camera lens was simply scaled down to the same focal length of the miniature lens, it would encounter many issues." (Ex. 2013, Yan at 79.) Yan further explained: "Scaling down a conventional camera lens requires spatial tolerances to scale down with the same ratio, which is about the factor of 7. This creates a huge problem on the tolerance budget of element and surface decenter." (Ex. 2013, Yan at 83.)

83. The fact that scaling of conventional lens designs to miniature size is impractical was known prior to 2009, as explained a paper by Bareau and

[15] Many histories credit Thomas Dallmeyer with inventing the telephoto lens in 1891. (https://en.wikipedia.org/wiki/Telephoto_lens)

[16] Dr. Yan currently works as an optical engineer at Apple. https://www.linkedin.com/in/yufengyan/

Clark that Dr. Sasián cites in his textbook (Ex. 2006, Sasián at 195) and that Apple has relied upon as a prior art reference in another IPR challenging a Corephotonics patent (IPR2018-01146, Ex. 1012). Bareau and Clark state:

> When designing a camera module lens, it is not always helpful to begin with a traditional larger-scale imaging lens. ***Scaling down such a lens will result in a system that is unmanufacturable***. . . . For glass elements, the edge thicknesses will become too thin to be fabricated without chipping. To achieve a successful design we have to modify our lens forms and adjust the proportions of the elements.

(Ex. 2012, Bareau at 1.) Bareau and Clark describe a number of issues that arise when scaling a 35 mm lens to a lens for a 1/4-inch sensor: "smaller entrance pupil" leading to greater depth of field and more sensitivity to diffraction, tighter "surface figure tolerances," tighter "geometric tolerances," tighter "angular tolerances," "stray light considerations," and "scratch/dig and contamination." (Ex. 2012, Bareau at 3.)

84. Dr. Sasián further explains the manufacturing problems encountered when lens designs become smaller in his textbook on lens design. He explains that for miniature lenses, "lens tolerances for lens thickness and decenter become tighter." (Ex. 2006, Sasián at 187.) Dr. Sasián elaborates:

> "As mentioned before, one problem with the small scale of miniature lenses is that lens element thickness and decenter errors can have a large impact by decreasing performance. For example, a thickness error of 0.1 mm can be tolerable in a 50

> mm focal length lens, but not at all in a miniature lens with a focal length of 5 mm. Therefore, an important part of the lens design is to desensitize as much as possible a given design."

(Ex. 2006, Sasián at 192.)

85. Bareau and Clark also describe the importance of desensitizing a miniature lens design: "One of the most challenging aspects of designing lenses for camera modules is desensitizing the system. If sensitivity to manufacturing tolerances is not built into the merit function, ***then the lens will not be manufacturable***." (Ex. 2012, Bareau at 9.)

86. A POSITA would recognize that a conventional lens designed for medium-format film, such as that in Kawamura, would not be desensitized as required if it were scaled down by a factor of 14 to 20. This is especially true of a lens designed in 1981, when the computer simulation abilities to study and reduce lens sensitivity were limited. For this reason, a POSITA in 2009 or in 2013 would not expect the Kawamura lens to be successful if scaled down for use in Golan. Dr. Sasián's declaration is silent on this important issue.

87. A POSITA in or around 2013 simply would not have looked to a 200-mm lens designed in 1981 in selecting a design for Golan's narrow lens. Rather, the POSITA would look to designs that were purpose-made for miniature

cameras and that took advantage of three years of technological improvement. As Dr. Sasián explains in his textbook, evolutionary development from existing miniature lens designs is the standard approach in the field: "[m]obile phone lenses have been evolutionary, in that every generation increased complexity from the previous one." (Ex. 2006, Sasián at 190.) There was also no shortage of miniature lens designs for a POSITA to use or to improve on: "[t]he patent literature has hundreds of lens design examples for mobile phone lenses and their forerunners, personal digital assistants." (Ex. 2006, Sasián at 190.) A POSITA would not have been motivated to go beyond rich literature of miniature lens designs and try scaling old lenses, designed for different purposes, with little reason to expect the result would be manufacturable.

b. A POSITA Selecting a Lens for Golan Would Have Used an Aspheric Design with Plastic Elements

88. A critical feature that was available in miniature lenses in 2009 or 2013, but not easily achieved in 1981, is the use of aspheric surfaces, made possible through the use of molded plastic materials and improved computation resources. Aspheric surfaces have numerous degrees of freedom to their shape (compared to a single radius of curvature for a spherical surface), and adjusting these parameters allows the lens designer to reduce aberrations and improve the performance of a lens. Because of the superior performance they

provide, aspheric lenses have become ubiquitous, particularly in the design of miniature lenses.

89. Dr. Sasián and his Ph.D. students have acknowledged that aspheric surfaces are a necessary feature of miniature lenses: "Mobile lenses are notorious by the extensive use of aspheric surfaces. The interaction of multiple aspherics within the design allows for effectively controlling aberrations." (Ex. 2007, Reshidko and Sasián at E217.) "To achieve good optical performance for the miniature cameras, aspherical surfaces are extensively used during the lens design." (Ex. 2010, Yan and Sasián at 1.) "In order to efficiently correct aberrations, aspherical surfaces are used extensively with injection molding of plastic." (Ex. 2010, Yan and Sasián at 1.) "The rear group of miniature camera lenses usually contains one or two elements that are strongly aspheric to correct field curvature, astigmatism and distortion." (Ex. 2010, Yan and Sasián at 1.)

90. Dr. Sasián's student Yufeng Yan elaborated on these issues in his Ph.D. dissertation, explaining that "to achieve good optical performance, aspherical surfaces are extensively used during the miniature lens design, usually employing up to 16th order terms." (Ex. 2013, Yan at 77–78.) "For miniature

lenses, injection molding is typically used to manufacture the small-scale lens elements with high order aspherical surfaces." (Ex. 2013, Yan at 83.)

91. Dr. Sasián's textbook explains that "[a]spheric surfaces provide effective degrees of freedom to correct all orders of spherical aberration" (Ex. 2006, Sasián at 27) and that in miniature lenses, "[t]o aid in the correction of aberration, highly aspheric surfaces are used" (Ex. 2006, Sasián at 187). He further explains that plastic lens elements make possible the use of aspheric elements and provide other advantages: "Some advantages of plastic lens molding are the freedom to specify aspheric surfaces, and the choice to specify a lens flange to help precisely position a lens element with respect to other lens elements, thereby simplifying the lens system assembly." (Ex. 2006, Sasián at 194.)

92. The importance of aspheric surfaces and plastic lens elements in miniature lens designs was recognized prior to Golan's 2009 priority date:

> "The majority of these lenses are all-plastic although some incorporate one glass element (usually the front element) for the advantages of high-index refraction and color correction. Plastic elements are almost always bi-aspheric, and frequently the aspheres are not subtle!"

(Ex. 2012, Bareau at 8.)

93. Simply scaling traditional glass designs leads to manufacturing difficulties:

> "Traditional glass lenses have similar types of requirements but with different values, based on their own manufacturing processes. The inability of lens manufacturers to accurately center the outer dimension of these elements on the optical axis, makes precise mounting very difficult. The benefits of traditional glass is reduced as the TTL requirements become shorter."

(Ex. 2012, Bareau at 8.)

94. Clark's 2014 paper confirms that aspheric surface and plastic materials remained "necessary" in the design of miniature camera modules: "The designs of these MCM lenses are very different than those we are used to seeing for larger cameras. Why? . . . Plastic materials. For cost, and to allow the aspheric surfaces necessary for performance." (Ex. 2011, Clark at 4.)

95. Based on a review of patented miniature digital camera lens designs, Clark observed that there are "several characteristics that separate" miniature digital camera lenses from traditional lens designs, including "[e]xtensive use of aspherics, including a large final surface, which is concave in the center and turning back before the edge of the surface." (Ex. 2011, Clark at 4.) He further found that in patented designs, "materials shift[ed] completely to the newer types" of plastics and that use of "high-order aspherics" had become

"uninhibited." (Ex. 2011, Clark at 5.) Clark further observes that "[t]he asphere-dominated design form that has developed for these products appears to have been known for less than twenty years," i.e., since some time after 1994. (Ex. 2011, Clark at 8.)

96. Both in 2009 and in 2013, a POSITA would have recognized that the best materials for making miniature lens elements were plastics. This is another reason that the POSITA would not have looked to scale Kawamura's lens designs. The optical performance of the lens depends on the index of refraction of each lens element, and the aberrations of the lens depend on the Abbe numbers of each lens element. A significant change in the index of refraction or the Abbe number can change a highly performing lens design into an unacceptable design.

97. The indexes of refraction and Abbe numbers required by the Kawamura designs are not available in plastic materials. This can be seen by the following "glass map," a plot index of refraction on the vertical axis and Abbe number on the horizontal axis, taken from Figure 4 of Clark:

0 >@#7!:5!$*+ ABACBBDEF
" 5(5!*>87;8!# :5!GBBGHDBE

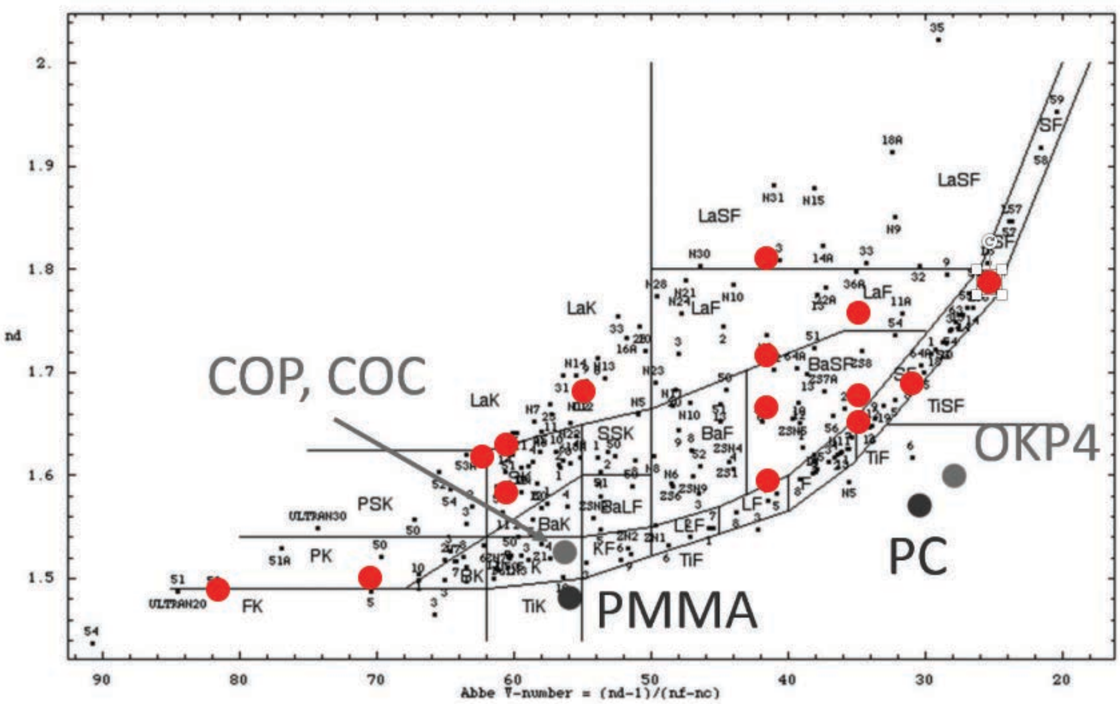


Figure 4. Glass map indicating plastic optical materials.

!

Q&^5!ABGG6!0U≈c!>8!DQ7[![:8 @![[7[R5R

FE5 . ; ! 8I 9@!_U86 8 7! @V>UYU>]c! [: 8@]: <<7@;_[! 8 ! >=>9U>YU7! : _89]>U

ZU>@@7@[68 7!U<Z!Z<>`!>;[! YU>]c![: 8@]! <<7@;_[!8 !>=>9U>YU7!: _89]>U_U>@C

89]@5%I7!>[[7 [! <7[! [:8 @]:<<7@;;[! 8! 8I7 !_<_7<897@;\ !8I7 !- >? >VW≈!U7;@

7U7V7;8@5) @8I9@@;? @68 7 !>=>9U>YU7!:_89]>U_U>@89]@]>=7!@Z;9\9]>;8U! [9\C

\7<7;8!9[7^! :\ !<7\<>]89;! >;[j :<!) YY7;!WVY7!\<V !8I7!:_89]>UZU>@@V@7[

9,! 8I7 !- >? >VW≈![7 @Z;@5%I9@9@>!\W8I7<!<7>@;! 8I>8>!*. ($%) !? :W[JI>=7!

U:c7 [! 8! >!I9ZIC_7<\:<V9, Z6 V>; W>]8W>YU7!V9, 9>8W<7!U7; @[!7@Z9 6<>87<!

than trying to scale a decades-old design that requires the use of glass lens elements.

c. A POSITA Selecting a Lens for Golan Would Have Used a Design with an Aperture Stop Near the First Lens Element

99. Another feature that a POSITA in 2009 or in 2013 would have recognized is essential in a miniature camera lens design is that the aperture stop be at or near the front of the lens assembly. As Dr. Sasián's Ph.D. student Yufeng Yan stated in his Ph.D. dissertation, placing the stop position at the front of the lens was the "first required design change" between conventional lens designs and miniature lens designs. (Ex. 2013, Yan at 80.) He explained this is necessary to "minimize image space CRA" or chief ray angle and to reduce the telephoto ratio. (Ex. 2013, Yan at 80.) A higher than necessary CRA "causes rapid drop of relative illumination towards the edge of image that requires digital compensation to the final image." (Ex. 2013, Yan at 81.)

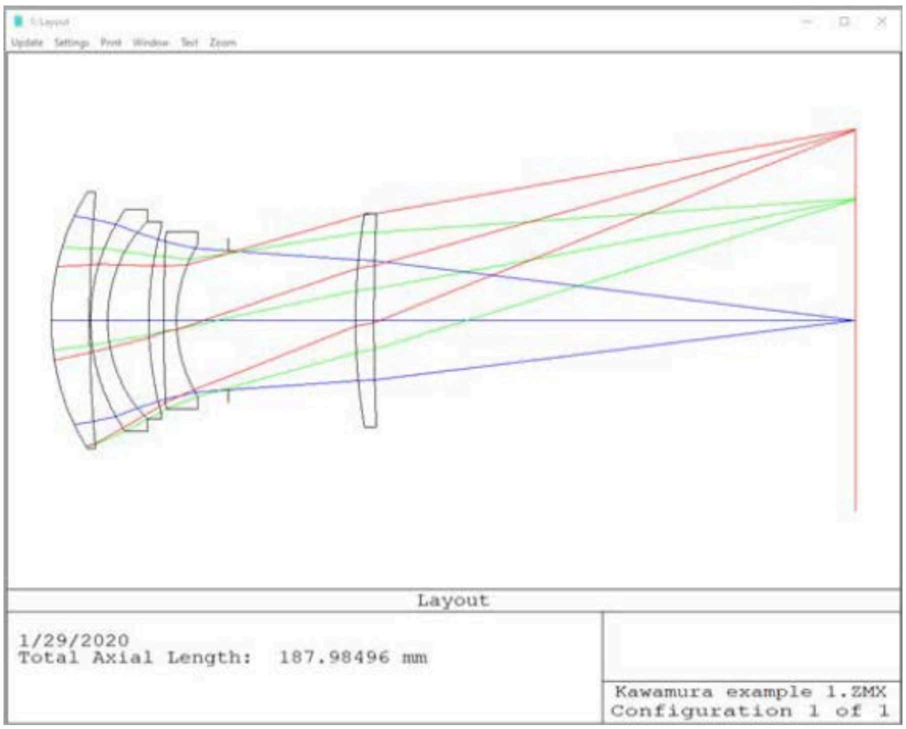
100. Dr. Sasián and another Ph.D. student explained that for miniature lenses:

> "The chief ray incidence angle (CRA) depends on the stop position and on the amount of pupil spherical aberration. The CRA impacts the relative illumination, which often is set to 50% at the sensor corners. . . . For better CRA control, the aperture stop is placed close to the front of the lens, away from the image plane. The aperture stop position and the strong aspheric next to

> the image plane generate exit pupil spherical aberration, which reduces the CRA."

(Ex. 2007, Reshidko and Sasián at E217.)

101. To understand the issue Dr. Sasián is describing here, it is helpful to look at a ray trace, such as the following one that Dr. Sasián performed of Kawamura's first example:



(Ex. 1003, Sasián Decl. at 62.) Rays in this figure travel from left to right, reaching the film, shown as a vertical red line on the right of the figure. The blue rays that strike the center of the film hit the film at close to the perpendicular. The red rays at the edge of the field that strike the edge of the film do so at a larger angle to the perpendicular to the sensor. This can be quantified

by measuring the angle from the perpendicular of the "chief ray," which is the ray that passes through the center of the aperture stop and hits the edge of the film (or sensor). In this figure, the chief ray is approximately the middle one of the three red rays.

102. The brightness of the image varies depending on the angle that the light is incident on the film or sensor. Parts of the sensor that receive light at a perpendicular are brightest, while parts of the sensor that receive light at an angle are dimmer as the angle from the perpendicular increases. The ratio of the brightness between the center of the sensor and the edge is called the relative illumination, and it is desirable to reduce this ratio to provide a more uniform image. To achieve this, the chief ray angle should be kept as small as possible. As Dr. Sasián and his Ph.D. students explained in the statements quoted above, the chief ray angle in a system with aspheric lenses is reduced by placing the aperture stop close to the front of the lens. (Ex. 2013, Yan at 80; Ex. 2007, Reshidko and Sasián at E217.)

103. The need to place the aperture stop close to the front of the lens in a miniature lens system was recognized before 2009. For example, Bareau and Clark explained that "[t]he aperture stop is usually towards the front of the

lens, often before the first element, which helps CRA and TTL." (Ex. 2012, Bareau at 8.)

104. Based on a review of patented miniature digital camera lens designs, Clark observed that there are "several characteristics that separate" miniature digital camera lenses from traditional lens designs, including that the "[a]perture stop is close to the front of the lens." (Ex. 2011, Clark at 4.)

105. As explained above, Dr. Sasián's simulations of the Kawamura lenses show that these lenses were designed to have the aperture stop in the middle of the lens assembly, between the fourth and five lens elements. (Ex. 1003, Sasián Decl. at 62–65.) As also explained above, a POSITA would recognize that this stop location was needed to reduce aberrations in this design lacking aspheric surfaces and made without the benefit of modern computation. This is a further reason that a POSITA would not expect scaling of the Kawamura lens designs to successfully provide a lens with performance suitable for use in Golan's system.

d. A POSITA Selecting a Lens for Golan Would Not Have Used a Lens with F-Number of 4

106. As explained above, the f-number of the lens determines how bright the image produced on the sensor is for a given scene, i.e., how much light reaches

each unit of area of the sensor per unit of time. This relationship is independent of other lens characteristics such as field of view or telephoto ratio.

107. The brightness varies as one over the square of the f-number, so that a lens with f-number of 4.0 produces an image roughly one half as bright as a lens with f-number 2.8. The small size of the pixels in miniature camera sensors means that they require more light per unit area to produce an accurate image. In order to maintain acceptable exposure times, it is important to make the f-number as small as practical.

108. Dr. Sasián recognized the importance of low f-number in miniature cameras: "Due to the demand of low-light performance of the miniature cameras, larger aperture lenses with lower F/# are desired." (Ex. 2010, Yan and Sasián at 1.) In this paper, Dr. Sasián uses as a "benchmark lens" a lens with f-number equal to 2.2.

109. The need for small f-numbers was recognized prior to 2009. For example, Bareau and Clark state that "typical lens specifications" for a 1/4-inch sensor format include a f-number of 2.8. (Ex. 2012, Bareau at 3.) They further explain:

> Although most camera module customers specify f/2.8, it is not uncommon to see lenses at f/3.0 and f/3.3 when the increased

> fno has a significant effect on performance or manufacturability. However, smaller pixel sensors have less light gathering capability and will suffer at slower f/numbers.

(Ex. 2012, Bareau at 4.)

110. Based on a review of patented miniature digital camera lens designs, Clark observed that there are "several characteristics that separate" miniature digital camera lenses from traditional lens designs, including that the "f/number is between f/3 and f/2," i.e. that the f-number is between 2 and 3. (Ex. 2011, Clark at 4.)

111. The f-number of the Kawamura lenses is 4.1. (Ex. 1007 at 3–5.) This is substantially less bright than the f-numbers described as typical for miniature lenses by Dr. Sasián and by Bareau and Clark, e.g., less than half as bright as a lens with f-number 2.8. A POSITA would have recognized the importance of a small f-number lens in the miniature camera of Golan. This is another reason that a POSITA would have looked to existing miniature lens designs, rather than the old Kawamura design, directed to an entirely different purpose.

B. Claim 6 Is Not Obvious over Golan in Combination with Kawamura

112. Dependent claim 6 requires a "smooth transition" when switching between a lower zoom factor (ZF) value and a higher ZF value or vice versa. Dr.

question again? 10:59

BY MR. RUBIN: 10:59

Q So why might one skilled in the art have 11:00 thought that modifications to Kawamura would have 10:59 been needed in order to accommodate the teachings of 10:59 Kawamura in the system of Golan? 10:59

A Well, a POSITA would look at Golan and 11:00 would look at Kawamura and may use Kawamura to 11:00 satisfy the needs of Golan in having telephoto lens. 11:00 And dependent on a given selected image sensor, that 11:00 person would scale the Kawamura lens to do -- fill 11:00 the sensor. Where it's a small sensor or a large 11:00 sensor, lenses scaling is typically done to adjust 11:00 lenses for a given specification. In this case, it 11:00 would be the dictated by the choice of sensor. 11:01

Q Would you agree that one of the goals of 11:01 the Golan reference is achieving a -- a system with 11:02 Zoom that is lightweight? 11:02

A Yes. That is mentioned by Golan. 11:02

Q And in the context of a digital imaging 11:02 system, would you consider the medium telephoto 11:02 lenses of Kawamura to be lightweight? 11:02

MS. SHI: Objection. Form. 11:02

THE DEPONENT: In comparison to other 11:03 standard lenses, yes, they would be lightweight. 11:03

BY MR. RUBIN: 11:03
Q Like, what other standard lenses are you referring to? 11:06 11:03
A Such as not being telephotos. 11:03
Q So -- so there, you're comparing the telephoto lenses of Kawamura to a lens with a similar focal length that's not telephoto? Is that the comparison you're making? 11:04 11:04 11:04 11:05
A Yes, along those lines. 11:05
Q So -- so you refer here in Paragraph 64 to scaling the Kawamura lens prescriptions to fit into the digital camera of Golan. How much would ones skilled in the art scale the lens prescriptions of Kawamura in order to achieve that combination? 11:06 11:06 11:06 11:06 11:06
A Well, as I said before, depending on the choice of image sensors, a person of skill would scale the lenses of -- the lenses of Kawamura. For example, Golan at some point specifies a 5 megabyte -- 5 megabyte sensor. And the diagonal of such sensor may be -- I don't recall the exact number, but maybe 3 millimeters. I mean, half a diagonal and divided it by the tangent of the center field of view, which, as I said before, is about .2. So that would require focal length of about 15 millimeters, and -- and so the scaling would be a 11:06 11:07 11:07 11:07 11:07 11:07 11:07 11:07 11:07 11:08 11:08

factof one-tenth. 11:08

Q So you just mentioned Golan referring to a sensor having -- I think you said 5 megabytes, but did you mean 5 megapixels? 11:08

A Megapixels, yes. Sorry for that. 11:08

Q So on the screen right now and also available in the chat function is Exhibit 1005, which is the Golan patent application publication. And so here in Paragraph 4 of Golan, it refers to an image sensor array having 5 megapixels? 11:09

(Exhibit 1005 was marked.) 11:09

THE DEPONENT: Yes. 11:09

BY MR. RUBIN: 11:09

Q And so is this the sensor you were referring to when you were describing a sensor that was 3 millimeters in -- in dimension? 11:09

MS. SHI: Objection. Form. Misstates testimony. 11:09

THE DEPONENT: I said, for clarification, about 3 millimeters in semi-diagonal, so the diagonal would be -- I don't recall the document, but about 6 millimeters. 11:10

BY MR. RUBIN: 11:10

Q Okay. And so the ratio between the 11:11
sensor -- the size of the sensor described here in 11:10

Golan and the size of the sensor described in 11:10
Kawamura is about 15:1; is that right? 11:10
A Maybe one-tenth. 11:10
Q Okay. So, roughly speaking, to use the 11:10
lens examples in Kawamura with the sensor described 11:10
in Golan, one skilled in the art would need to scale 11:11
the lens prescriptions in Kawamura down by a factor 11:11
of roughly 10? 11:11
MS. SHI: Objection. Form. 11:11
THE DEPONENT: That's one of (inaudible). 11:11
CERTIFIED SHORTHAND REPORTER: I didn't 11:11
hear the answer. 11:11
THE DEPONENT: That will be one 11:11
possibility. 11:11
BY MR. RUBIN: 11:11
Q What would be other possibilities? 11:13
A To use different sensor size, smaller 11:14
sensors or lighter sensors. 11:11
Q In Kawamura, would you agree that each of 11:12
the four examples that are described include -- 11:12
withdrawn. 11:12
Would you agree that in Kawamura, each of 11:13
the examples that are described include a laminated 11:13
positive meniscus lens? 11:13
MS. SHI: Objection. Form. Ambiguous. 11:13

Table 17.4 *Properties of some plastics used in mobile phone lenses*

Code	n_d	v	γ	ρ
480R	1.525	55.95	$+1.44 \times 10^{-4}$	1.01
E48R	1.531	56.04	-2.62×10^{-4}	1.02
F52R	1.534	57.09	-2.21×10^{-4}	1.01
OKP4	1.607	26.90	-3.44×10^{-4}	1.20
OKP4HT	1.632	23.33	-2.72×10^{-4}	1.24

n_d, index of refraction; v, v-number; γ, opto-thermal coefficient; ρ, specific gravity.

The optical and mechanical properties of some plastics used in miniature lens systems are shown in Table 17.4. Some advantages of plastics over glass are that they are moldable at a lower temperature, have lower cost for large volumes, with lower weight, and aspheric and diffractive surfaces can be specified. Some disadvantages are the greater sensitivity to temperature changes, increased sensitivity to water absorption, internal light scattering or haze, reduced light transmission below 450 nm and above 1,000 nm, and a low resistance to abrasion.

Further Reading

Bareau, Jane, Clark, Peter P. "The optics of miniature digital camera modules," Proceedings of SPIE 6342, International Optical Design Conference 2006, 63421F (2006), doi: 10.1117/12.692291.

Clark, P. "Lens design and advanced function for mobile cameras," Chapter 1, in *Smart Mini-Cameras*, Galstian, T. V., ed. (Boca Raton, FL: CRC Press, 2014).

Clark, Peter P. "Mobile platform optical design," Proceedings of SPIE 9293, International Optical Design Conference 2014, 92931M (2014), doi: 10.1117/12.2076395.

Reshidko, D., Sasián, J. "Optical analysis of miniature lenses with curved imaging surfaces," *Applied Optics*, 54(28) (2015), E216–23.

Schaub, M. *The Design of Plastic Optical Systems* (Bellingham, WA: SPIE Press, Vol. TT80, 2009).

Sure, Thomas, Danner, Lambert, Euteneuer, Peter, Hoppen, Gerhard, Pausch, Armin, Vollrath, Wolfgang. "Ultra-high-performance microscope objectives: the state of the art in design, manufacturing, and testing," Proceedings of SPIE 6342, International Optical Design Conference 2006, 63420E (2006), doi: 10.1117/12.692202.

Yan, Yufeng, Sasián, José. "Miniature camera lens design with a freeform surface," Proceedings of SPIE 10590, International Optical Design Conference 2017, 1059012 (2017), doi: 10.1117/12.2292653.

Links to optical plastics vendors:

http://www.ogc.co.jp/e/products/fluorene/okp.html

https://www.zeonex.com/Optics.aspx.html#glass-like

TABLE 1.1 Comparison of Camera Formats

(a) Miniature Camera Modules, Digital Cameras, and Film Cameras[a]

Inch-Format	Horizontal (mm)	Vertical (mm)	Diagonal (mm)	Area (mm²)	Megapixels	Minimum Pixel (mm)	Maximum Pixel (mm)	Linear Scale (35 mm ref) (%)	Area Scale (35 mm ref) (%)	Typical Minimum f/number	EFL	Entrance Pupil Diameter
Miniature Camera Modules												
1/6	2.32	1.74	2.90	4.04	1.3–2	0.0014	0.0017	7	0.4	2	2.28	1.14
1/5	2.80	2.10	3.50	5.88	2–3	0.0014	0.0017	8	0.7	2	2.75	1.37
1/4	3.60	2.70	4.50	9.72	3–5	0.0014	0.0017	10	1.1	2.4	3.53	1.47
1/3	4.80	3.60	6.00	17.28	5–8	0.0014	0.0017	14	1.9	2.8	4.71	1.68
Digital Still Cameras												
1/2.3	6.08	4.56	7.60	27.72	12–16.6	0.0015	0.0022	18	3.1	2.8	6.0	2.1
1/2	6.40	4.80	8.00	30.72	16	0.0014	0.0014	18	3.4	2.4	6.3	2.6
1/1.7	7.44	5.58	9.30	41.52	10–12	0.0019	0.002	21	4.6	2	7.3	3.6
1	13.20	8.80	15.86	116.16	14.2	0.0029	0.0029	37	13	2	12.5	6.2
APS-C	23.60	15.80	28.40	372.88	12.2–24.7	0.0039	0.0055	66	43	2	22.3	11.1
FULL	36.00	24.00	43.27	864.00	18.1–24.7	0.0059	0.0069	100	100	1.4	34.0	24.3
Film Cameras												
Disc	11.0	8.0	13.6	88				31	10	2	10.7	5.3
APS-H	30.2	16.7	34.5	504				80	64	2	27.1	13.5
35 mm	36.0	24.0	43.3	864				100	100	1.4	34.0	24.3
6 × 6 cm	60.0	60.0	84.9	3600				196	385	2.8	66.6	23.8
4 × 5 in.	127.0	101.6	162.6	12903				376	1413	4.5	127.6	28.4

E216 Vol. 54, No. 28 / October 1 2015 / Applied Optics Research Article

applied optics

Optical analysis of miniature lenses with curved imaging surfaces

DMITRY RESHIDKO* AND JOSE SASIAN

College of Optical Sciences, The University of Arizona, Tucson, Arizona 85721, USA
*Corresponding author: dmitry@optics.arizona.edu

Received 18 May 2015; revised 13 August 2015; accepted 5 September 2015; posted 9 September 2015 (Doc. ID 241176); published 23 September 2015

Miniature cameras for consumer electronics and mobile phones have been, and continue to be, in fast development. The system level requirements, such as manufacturing cost, packaging, and sensor characteristics, impose unique challenges for optical designers. In this paper, we discuss the potential optical benefits of having a curved image surface rather than a flat one. We show that curved sensor technology allows for optically faster lens solutions. We discuss trade-offs of several relevant characteristics, such as packaging, chief ray angle, image quality, and tolerance sensitivity. A comparison of a benchmark flat field lens, and an evaluation design imaging on a curved surface and working at $f/1.6$, provides useful specific insights. For a given image quality, departing from a flat imaging surface does not allow significantly reducing the total length of a lens.

OCIS codes: (220.3620) Lens system design; (220.1000) Aberration compensation; (220.1010) Aberrations (global).

http://dx.doi.org/10.1364/AO.54.00E216

1. INTRODUCTION

Miniature camera lens modules are integrated in a variety of portable devices, including cell phones, tablets, laptops and spy cameras, to mention common applications. The photographic performance of these tiny, always ready-for-action lenses, is remarkable as it rivals that of single-lens reflex cameras. Mobile camera technology and devices is a very fast growing field in the imaging market and is impacting the industry by decreasing the production of larger photographic cameras.

The design and packaging of a miniature camera lens module imposes optical design challenges. A traditional objective lens can not be simply scaled down as a lens solution due to fabrication constraints, materials properties, manufacturing process, light diffraction and geometrical aberrations. The increasing demand for thinner, lighter, and low-cost mobile cameras has thus forced the development of new manufacturing technologies and of lens design solutions with high performance.

The optical advantages of using a curved image sensor have been already discussed in the literature. A general conclusion is that a curved image surface allows designing simpler, more compact, and lower-cost optics [1–3]. Recently several researchers have made progress toward developing curved sensors [4–8].

The curved sensor technology for the format which is suited for mobile cameras is near to being commercialized. On the 2014 VLSI Symposia, Sony officially released two curved sensors. One has a diagonal of 43 mm, which is equivalent to a full-frame sensor. The other has a diagonal of 11 mm, which corresponds to a 2/3 in. sensor format [9]. For reference, a flat 2/3 in. sensor has been used in the Nokia Lumia 1020 smart phone camera module.

In this paper, we analyze how allowing for a curved imaging surface impacts the lens design of compact miniature lenses for mobile applications. In Section 2, we highlight typical optical design specifications of state-of-the-art mobile camera lenses. We derive design requirements by comparing products in the market, from patent data, and from publications in the mobile platform optical design and fabrication sector. We review the first-order imaging properties and discuss aberration correction in this class of miniature lenses. In Section 3, we examine how a curved image surface can benefit the lens design of mobile cameras. In Section 4, we show lens design examples for both flat and curved image surfaces. Section 5 provides a detailed comparison of the designs presented in the previous section. We find that a curved image surface allows producing an equivalently performing design with faster $f/\#$ than a conventional design. We also show that other relevant characteristics, such as aberration balancing, image quality, and chief ray incidence angle on the sensor, are favorably impacted. In addition, we discuss distortion aberration as it relates to a curved imaging surface. Finally, we demonstrate improved sensitivity to manufacturing tolerances. Section 6 concludes this paper.

2. REVIEW OF MODERN MOBILE CAMERA LENSES

In this section we present typical optical design requirements and trade-offs of state-of-the-art mobile camera lenses. First,

The Optics of Miniature Digital Camera Modules

Jane Bareau and Peter P. Clark
Flextronics Optical Technology Center, 1 Upland Road, Norwood, MA, USA 02062

ABSTRACT

Designing lenses for cell phone cameras is different from designing for traditional imaging systems; the format poses unique challenges. Most of the difficulty stems from the scale of the system, which is based on the size of the sensor.

Keywords: Optical design, lens design, digital cameras

1. INTRODUCTION

The scale of cell phone camera systems creates particular challenges for the lens designer that are unique to this format. Both the size and the low-cost requirements have many implications for the design, fabrication and assembly processes.

Fig.1: This 3.6um pixel VGA camera module is 6.05 x 6.05 x 4.5 mm.
The most critical dimension is the 4.5 mm axial length.

For those of us who have been involved in the design and manufacturing of consumer and commercial imaging systems using lens elements with diameters in the 12-40mm range, the switch to much smaller elements with diameters in the 3-5mm range takes some adjustment. When designing a camera module lens, it is not always helpful to begin with a traditional larger-scale imaging lens. Scaling down such a lens will result in a system that is unmanufacturable. If the design includes molded plastic optics, a scaled down system will result in element edge thicknesses shrinking to the point where the flow of plastic is affected. For glass elements, the edge thicknesses will become too thin to be fabricated without chipping. To achieve a successful design we have to modify our lens forms and adjust the proportions of the elements.

Layout drawings can be very misleading. Many times we find ourselves surprised when the mechanical layout of a lens barrel that looked reasonable on paper turns out to be very difficult or impossible to fabricate. Tabs on a barrel that appear substantial in a drawing, are found to be too flimsy to function on the actual part, “sharp” edges on molded stops don’t fill completely because the features are too small. The size of the lenses and mechanical details on the flanges and barrels affect all aspects of the manufacturing process. Diamond tools have to be redesigned to be able to generate large changes in angle over small areas. Handling the lenses becomes difficult even with tweezers, all inspection and screening has to be done with a microscope. Measuring basic dimensions and the surfaces of the lenses becomes very challenging. Center thickness and surface decenter measurements in particular are difficult at the high levels of accuracy required for current designs. The ability to fabricate accurate and robust fixtures for measurement of individual elements has become absolutely critical.

International Optical Design Conference 2006, edited by G. Groot Gregory,
Joseph M. Howard, R. John Koshel, SPIE Vol. 6342, 63421F,

	35 mm point and shoot	35 mm single use	¼” CMOS
Film format diagonals:	43 mm	43 mm	4.4 mm
Lens EFL:	37.5 mm	37.5 mm	3.8 mm
f/number:	2.8, variable	11, fixed	2.8, fixed
Entrance pupil diam:	13.4 mm	3.4 mm	1.36 mm
Spatial frequencies:	10 – 40 /mm	10 – 20 /mm	50 – 100 /mm
Cost:	$10 (est.)	$0.50 (est.)	$1 (est.)

If we were able to simply scale the 35 mm lens design by 1/10x, we would encounter a few issues:

1) Smaller entrance pupil: Depth of field will be much greater, but diffraction will limit performance sooner than with larger formats.
2) Surface figure tolerances: Figure tolerances (fringes of irregularity, for example) will be somewhat tighter, because spatial frequencies of interest are higher, but because the surfaces are smaller, they will be easier to achieve in practice.
3) Geometric tolerances: Scaling the system’s size requires linear tolerances to scale as well. So center thickness tolerances and surface and element decenter tolerances will be tighter by a factor of ten. This proves to be the greatest challenge of producing these lenses.
4) Angular tolerances: Lens tilt tolerances do not scale down, but small defects on flanges or mounting surfaces will have a larger effect on tilt.
5) Stray light considerations: An aperture or baffle feature that has an acceptably small dimension at the large scale should be scaled down by 1/10. However, some parts cannot be made thin enough, or they may become translucent, so they will cause a larger fraction of the light to scatter from their edges, resulting in flare or veiling glare.
6) Scratch/Dig and Contamination: The smaller system is much more sensitive to defects and contamination causing shadowing on the image. Acceptable defect dimensions scale with the format size, and the situation is often worse in practice, because the back focal distance is very short and defects close to the image are more visible.

4. Specifications

The following are typical lens specifications for a ¼” sensor format:

FOV	60 degrees
Image Circle	4.6 mm diam.
TTL	5.0mm
f/no	f/2.8
Distortion	<2%
Chief Ray Angle	<22 degrees
Relative Illumination	>50%

FOV - The field of view for these systems is typically 60 to 66 degrees across the sensor diagonal, but the design must include a slightly larger angle to allow for correction over the image circle.

Image Circle - This is the diameter of the image over which the lens has to be well corrected to allow for lateral displacement of the sensor relative to the optical axis. Lens to sensor centration errors are caused mostly by uncertainty in the placement of the sensor on its circuit board. To allow for those errors, the lens image circle is increased by at least 0.2 mm. As sensors get smaller sensor placement accuracy must improve.

TTL- The total track length is the distance from the front of the barrel to the image plane, this has to be longer than the optical track length by at least 0.050mm in order to protect the front of the lens. This is extremely important to the cell phone designers because of the market pressure to produce thinner phones.

published as “Miniature camera lens design with a freeform surface” [39], and some of the materials are reused in this dissertation.

3.1 Design Challenges of a Miniature Camera Lens

When designing miniature camera lenses, lens designers are facing great challenges compare to designing conventional large-scaler camera lenses. The typical FOV of a primary camera lens on a portable device is about 70 to 75 degrees, with the focal length around 4 mm, and a maximum aperture around F/1.8. Fig 3.2 shows the comparison between a conventional camera lens designed by Nikon [40] and a miniature camera lens designed by Apple [41] with similar FOV and F/#. The detailed specs of these 2 lenses are shown in Table 3.1. Both designs are relatively up to date, with the Nikon patent filed in 2014 and the Apple patent filed in 2016. From Fig 3.2, it is clear that the design approaches and lens constructions are significantly different between a miniature camera lens and a conventional camera lens. Duo to the sensor size difference, the focal length of this miniature camera lens is about one-seventh of the focal length of the conventional camera lens with the same FOV and F/#. However, if the conventional camera lens was simply scaled down to the same focal length of the miniature lens, it would encounter many issues. The most severe issue is the limiting package size. Typically, the total track length (TTL) of a miniature camera today is around 5 mm to 6 mm in order to fit in the portable electronic devices. However, if the Nikon 28 mm lens was simply scaled down to the same focal length with the Apple 4 mm lens, its TTL would still be more than 3 times of the Apple lens and it would not be able to fit inside a modern portable electronic device such as cellphones and tablets. As mentioned in Chapter 2, wide-angle lenses for conventional cameras usually have an inverted telephoto structure with high telephoto ratio (ratio of TTL to focal length). To reduce the telephoto ratio and fit a wide-

dispersion can effectively correct chromatic aberrations in the system. Special designed achromatic doublets, also known as “new achromatic doublets”, can benefit with the correction of field curvature as well [42]. For miniature lenses, injection molding is typically used to manufacture the small-scale lens elements with high order aspherical surfaces. In order to maintain the cost, plastics or optical polymers are usually used for injection molding. However, selections of plastic materials are very limited with no ultra-low dispersion option. For example, only 2 different materials (besides the IR filter) were used in the Apple lens design presented in Fig 3.2. The limited choice of lens materials and the lack of ultra-low dispersion plastics make correcting chromatic aberration difficult. In addition, plastic doublets are difficult to manufacture, this further challenges the correction of chromatic aberration and field curvature. Also, even though the extensive use of aspherical surfaces helps with some aberration control, it has no effect on chromatic aberrations either.

Besides the design challenges, miniature lenses at small scales also creates problems during manufacture. The most obvious impact is the tolerance budget. Scaling down a conventional camera lens requires spatial tolerances to scale down with the same ratio, which is about the factor of 7. This creates a huge problem on the tolerance budget of element and surface decenter. Usually a decenter tolerance within couple microns is required for miniature camera lenses. This requires very precise lens molding and system assembly. Angular tolerances such as lens tilt does not scale with the lens, but small defects on mechanical mounts will have a larger effect on tilt.

With the market pressure to make thinner electronic devices and add more cameras per device, the package size constrain gets tighter. However, better optical performance, smaller F/# and larger FOV are also favored by customers, which requires more lens elements to be used. The conflict between these two requirements are really challenging to optical designers. Newer

about 252 grams. Do you see that?

A Yes.

Q So based on your calculation of the weight of Kawamura Example 1's glass, just in the clear aperture portions of the lens, being 183.3 grams, does it seem reasonable that adding the additional glass to permit mounting and the barrel and adding the weight of the barrel, the complete product would have a mass of around 252 grams?

A It is a reasonable estimate.

Q So it would be reasonable to estimate that the unmodified Kawamura lenses would have a mass of around 252 grams?

A I think that what I mean by a reasonable estimate is that the -- the weight of the Kawamura lens, including the barrel, would be the 252 grams.

Q So looking at your lens prescription table from Part A of the appendix of your reply declaration, can you remind me -- what does the letter S so the right of the thickness in the stop row indicate?

A Yes. In this case, the S is for a solve. And what it's solving is the distance between -- or the thickness of surface 7 and the thickness of surface 8 are added and made equal to a value I

A Yes.

Q And in the scaling that you did in Table 1 of your declaration, would you agree that the weight of the lens elements there scaled as the focal length cubed?

MS. SHI: Objection. Form.

THE DEPONENT: I would say that the mass scales as the cube of the relevant linear dimension.

BY MR. RUBIN:

Q So if I wanted to scale Kawamura's lens to have a focal length of 520 millimeters, would I -- would it be reasonable to expect that the weight of the resulting lens would be the weight of Kawamura's lens times 520 millimeters divided by 200 millimeters, that ratio cubed?

A That will be an estimate, yes.

Q So you have a calculator with you?

A Yes.

Q So what's the ratio of the 520-millimeter maximum focal length of the Fujinon lens without the extender and the 200-millimeter focal length of Kawamura's lenses?

A 2.6.

Q And, then, what's 2.6 cubed?

A About 17.576.

MS. SHI: General objection to counsel's questions. Out of the scope of expert's declaration in this proceeding. This is not an opportunity for Mr. Rubin to get answers for questions related to other IPRs.

BY MR. RUBIN:

Q So I have question for you about a particular paragraph here which, I think, is relevant to the opinions you've offered in this case concerning the '408 patent. So look at Paragraph 32 of your declaration concerning the '647 Patent. Starting with the second sentence, is says:

"Prior to July 4th, 2013, five-element lens assemblies for mobile phones were well-known, including telephoto lenses."

You cite to various exhibits. And then the next sentence reads:

"For example, Iwasaki APPL-009, Ogino APPL-005 -- 1005, Hsieh APPL-1025, and Chen APPL-1020 teach prior art similar multi-lens system with a TTL to EFL ratio of less than one."

Do you see that?

A Yes.

Q So is it true as you said here that the

Iwasaki, Ogino, Hsieh, and Chen patents all teach telephoto lens designs suitable for use in mobile phones?

A So I like to verify that indeed all of these patents have telephoto lens, meaning that the total length is less divided by the effective focal lenth is less than 1. But leaving aside the verification, my recollection right now is that, yes, this references teach telephoto lenses.

Q And do you still believe, as you said here, that prior to July 4th, 2013, quote, "five-element lens assemblies for mobile phones were well-known, including telephoto lenses"?

A Yes. I -- I believe that prior to July 4, five-element lens assemblies for mobile phones were well-known, including telephoto lenses, as I am showing some examples here.

Q And do you believe that prior to June 2013, telephoto lens designs for mobile phones were well-known?

A Could you please ask the question again?

Q Do you believe that prior to June 2013, telephoto lens designs for mobile phones were well-known?

A Yes. I do believe that prior to that date,

telephoto lenses for mobile phones were well-known. But to be consistent with my early comment, I don't think there were hundreds or hundreds of telephoto lenses.

Q So you -- you would agree that telephoto lens designs for miniature cameras were well-known before the priority date of the '408 patent. Where you disagree with Dr. Moore is that you disagree that there were hundreds of designs that were publicly known?

A Yes. I disagree that there were a vast amount of lens designs for miniature cameras that were telephoto.

Q But you would agree that there were at least several lens designs that were publicly known for telephoto and miniature cameras and that those designs were well-known?

A Yes. I do agree with that.

Q Bear with me just a moment.

Okay. So what I've just shared in the chat function and is also shared on the screen is a deposition transcript from a deposition that I took of you on January 22nd, 2021. And this is Exhibit 2003 in IPR2020-00878 concerning U.S. patent 10,330,897.

THE DEPONENT: It will depend relative to what?

BY MR. RUBIN:

Q In the field of camera design, are you aware of any commonly used definition for a lightweight camera or for a camera that's not lightweight?

A I think the term "lightweight" is relative. In some applications, something that is lightweight for another applications is very heavy and vice versa.

Q So does it depend on --

Does the question of whether something is lightweight depend on the application and on what other designs are available for use in that application?

A That is an example of the situation. In some cases, yes.

Q I'd like to ask you about Paragraph 49 in your reply declaration. So this paragraph is just after the paragraphs where you list Steps 1 through 5 that you performed in creating the design in Part B of your appendix. Do you see that?

A Yes.

Q All right. So the first sentence of

O'Brien, David

From: O'Brien, David
Sent: Thursday, September 15, 2022 11:29 AM
To: Trials
Cc: Neil Rubin; Marc Fenster; James Tsuei; Shi, Hong; Ehmke, Andrew S.
Subject: IPR2020-00489: Request to include eMail Communications in the Agency Record
Attachments: 2021-08-13 - Apple eMail (request to admit evidence) (with attachments).pdf; 2021-08-16 - Corephotonics eMail (opposing Apple request).pdf; 2021-08-17 - Apple eMail (re status of translation; highlighting urgency and good cause).pdf; 2021-08-18a - Board eMail (declining to address Korean brief until certified translation is ready).pdf; 2021-08-18b - Apple eMail (certified translation ready; renewing request for conference, extension and briefing) (with attachment).pdf; 2021-08-18c - Apple eMail (requesting entry of Golan Provisional) (with attachment).pdf; 2021-08-19 - Corephotonics eMail (opposing Apple request; requesting admission of Korean brief) (with attachment).pdf; 2021-08-20 - Board eMail (ruling without conference).pdf

Dear Honorable Board,

Petitioner respectfully requests inclusion in the Agency Record of the attached party communications to/from the Board. The written communications concern requests, in the above-entitled proceeding, to admit evidence and will properly be before the Court of Appeals. More specifically, the communications are the sequence of eMails (13-Aug-2021 to 20-Aug-2021) by which Apple requested admission of evidence, by which Corephotonics opposed, and by which the Board ruled regarding the Golan Provisional and on briefing relative to the Korean Brief. Including the written communications unambiguously in the Agency's record, e.g., as 3000-series exhibits, would help formalize the record on appeal and streamline the issues before the Federal Circuit.

The parties have met and conferred, and Corephotonics does not oppose.

HAYNES BOONE

David O'Brien
Partner
david.obrien@haynesboone.com

Haynes and Boone, LLP
600 Congress Avenue
Suite 1300
Austin, TX 78701-3285

(t) +1 512.867.8457
(f) +1 512.867.8613

vCard | Bio | Website

O'Brien, David

From: O'Brien, David
Sent: Friday, August 13, 2021 10:28 PM
To: Trials
Cc: Neil Rubin; Marc Fenster; James Tsuei; Jonathan Link; Shi, Hong; Parsons, Michael; Ehmke, Andrew S.
Subject: IPR2020-00489 // Petitioner's request to admit evidence with rehearing request
Attachments: 2021.08.02. 상대방 참고서면.pdf; Google Translate at 6.jpg; Google Translate at 2.jpg; Google Translate of p.1-2.jpg

Judges Moore, Anderson and Ullagaddi,

Petitioner writes following yesterday's oral hearing in IPR2020-00906 (before Judges Moore, Ullagaddi and Horvath) after which options for addressing a pending admission-of-new-evidence question relative to the IPR2020-00906 proceeding were discussed with the Board and amongst parties. Per the panel's suggestion, Parties have since conferred, and Patent Owner has agreed to withdraw its opposition to authorization for Apple's motion to admit new evidence into the IPR2020-00906 proceeding. The IPR2020-00489 proceeding presents an analogous question but has a different timeline, and the Trial Practice Guide (TPG) provides a conference call process for the panel to decide the evidence question prior to rehearing. See Consolidated TPG, 90 (November 2019) ("Ideally, a party seeking to admit new evidence with a rehearing request would request a conference call ….").

Apple respectfully requests the TPG-provided conference call with the Board regarding admission into the record of Patent Owner's admissions that contradict a critical position that it has taken in this proceeding and upon which the Board relied in its final written decision. Specifically, Apple seeks admission of a brief that Patent Owner Corephotonics filed on August 2, 2021 in the Korean IPTAB proceeding titled Case No. 2020 Heo 6323 (see attached pdf, hereinafter "Korean Brief"). The Korean Brief goes not simply to the weight and credibility of expert testimony, but is a party admission, which should carry at least persuasive—if not prosecution history and judicial—estoppel effect. Apple is obtaining a certified translation as required by 37 CFR § 42.63(b). Apple's counsel is, for purposes of this request and the conference call, relying on a machine translation until a certified translation is available.

Good cause exists for including the Korean Brief in the record because (1) the Brief was filed eleven days ago, just after the Board rendered its final written decision and (2) Patent Owner's admission concerns a fundamental issue underpinning its arguments in this proceeding—and specifically contradicts its position on that issue taken here. Here, Patent Owner argued against combining Golan and Kawamura, alleging that a POSITA would have looked to numerous "well-known" miniature telephoto designs in 2013 for use in Golan's system. For example, Patent Owner argues:

- "There was also no shortage of miniature lens designs for a POSITA to use or to improve on …" POR, at 46.
- "Dr. Moore's declaration explains that it was significant, significant enough that a POSITA would have recognized that the result of scaling Kawamura was inferior in terms of materials, design, manufacturability, and performance to more current 'well-known' miniature telephoto lens designs." Sur-Reply at 14 (relying on Dr. Moore's declaration at Ex. 2003, ¶87) (underline added).
- "[T]elephoto lenses specifically for mobile phones were well-known by 2013, not that we're limited to mobile phones, but the point is that if telephoto lenses were available now in miniature lenses in 2013, why would you need to go back to Kawamura for a telephoto lens." Hearing Transcript, 29:21-24 (underline added).

In the Korean proceedings, Patent Owner admitted the opposite to the Korean Patent Office and Supreme Court: that there were almost no telephoto lens assemblies for small form factors available in 2013.

- "At the time of filing for the [Subject Patent] (around 2013) there was only one precedent document that installed a telephoto lens assembly in a mobile terminal, and most of the camera manufacturers for mobile

terminals tried to develop a 'wide-angle lens assembly' rather than a 'telephoto lens assembly'. Google Translate of Korea Brief (see attached), at 2 (underline added).

- "… <u>there were hardly any telephoto lens assemblies applied to mobile terminals</u> at the time the patent invention was filed in this case." *Id.* at 2 (underline added).
- "At the time of filing for the patent in this case (around 2013), <u>there was almost no technology for mounting a telephoto lens assembly in a portable terminal</u> . . ." *Id.* at 6 (underline added).

Patent Owner's arguments in the Korean Brief contradict Patent Owner's arguments here that there were "well-known" miniature telephoto lens designs" or "no shortage" of miniature lens designs that would have been suitable by 2013 for the tele lens in Golan's camera. Petitioner therefore seeks to admit the Korean Brief and a certified translation into the record to show contradictory statements from Patent Owner about the availability of miniature telephoto lens designs in 2013.

Apple's counsel is available for the conference call with the Board on between 10am and 4pm, Tuesday or Wednesday, 17-18 August or otherwise at the panel's convenience. Patent Owner continues to oppose admission of the Korean Brief and translation into the IPR2020-00489 record but has not indicated its availability for the conference call.

During the discussion amongst Board and parties after yesterday's IPR2020-00906 hearing, the panel expressed concerns regarding timeline for certified translation, written briefing, and rehearing in this IPR2020-00489 proceeding. Apple is not opposed to written briefing of the good-cause-for-admission-of-new-evidence question in IPR2020-00489, provided that the panel can quickly turn a written Order and sufficiently extend the deadline for requesting rehearing without overrunning the 63-day deadline for appeal to the Federal Circuit.

HAYNES BOONE

David O'Brien
Partner
david.obrien@haynesboone.com

Haynes and Boone, LLP
600 Congress Avenue
Suite 1300
Austin, TX 78701-3285

(t) +1 512.867.8457
(f) +1 512.867.8613

vCard | Bio | Website

참 고 서 면

사 건	**2020허6323 등록무효(특)**
원 고	**코어포토닉스 리미티드**
피 고	**엘지이노텍 주식회사**

위 사건에 관하여 **원고 소송대리인**은 피고의 2021. 2. 8.자, 2021. 5. 28.자 준비서면에 대하여 다음과 같이 반박하면서 참고서면을 제출합니다.

다 음

1. 피고 주장의 요지 및 그 부당성

피고는 2021. 5. 28.자 준비서면에서 이 사건 정정발명은 ① 명세서의 뒷받침 기재 요건 및 용이실시 기재 요건이 결여되어 있고, ② 청구항의 명확, 간결한 기재 요건이 결여되어 있으며, ③ 신규사항 추가의 무효사유가 있다고 주장하고 있습니다.

또한 피고는 2021. 2. 8. 자 준비서면에서 이 사건 정정발명은 ④ 선행발명 1 단독에 의하여 또는 선행발명 1과 주지관용기술(또는 을 제5, 6호증의 선행기술)과의 결합에 의하여 진보성이 부정되고, ⑤ 이 사건 정정발명은 출원일이 우선일로 소급되지 않으므로, 선행발명 2와 동일하여 확대된 선출원 위반의 무효사유가 있다는 주장을 반복하고 있습니다.

그러나 피고의 주장은 모두 이유 없습니다.

이하에서는 먼저 재판부께서 2021. 6. 10.자 변론기일에서 질의하신 사항에 대하여 보충 설명드린 후 피고 주장의 부당성에 대하여 구체적으로 말씀 드리겠습니다.

2. 2021. 6. 10.자 변론기일 재판부 질의사항에 대한 보충 설명

가. 이 사건 특허발명 출원 당시의 휴대 단말기에 적용된 카메라 현황

이 사건 특허발명은 휴대 단말기에 장착되는 망원 렌즈 조립체에 관한 원천기술이고 현재까지 널리 사용되고 있습니다.

이 사건 특허발명 출원 당시(2013년경) 휴대 단말기에 망원 렌즈 조립체를 장착하는 선행문헌은 1건에 불과하였고,[1] 휴대 단말기용 카메라 제조업체 대부분은 '망원 렌즈 조립체'가 아닌 '광각 렌즈 조립체'를 개발하려고 노력하고 있었습니다.[2]

이 사건 특허의 명세서 단락 [0004], [0005]는 종래기술로 4개의 렌즈 요소들을 포함하는 렌즈 조립체는 소형의 이미지 촬영 렌즈 시스템으로서 양호한 품질의 이미지를 얻기에 충분하지 않았고 5개의 렌즈 요소들을 사용한 (광각 렌즈 조립체인) US 제8,395,851호는 TTL 및 EFL 사이의 비율이 큰 문제점이 있다고 기재하고 있습니다. 이는 이 사건 특허발명 출원 당시 휴대 단말기에 적용되는 망원 렌즈 조립체가 거의 없었기 때문입니다.

등록특허 10-1757101

요는 성장을 계속하고 있다. 특히, 휴대 장치 내에서 카메라는 양질의 이미지 촬영을 위한, 그리고 작은 총 트랙 길이(TTL)를 갖는 소형의 이미지 촬영 렌즈 시스템을 필요로 한다. 4개의 렌즈 요소들을 포함하는 종래의 렌즈 조립체는, 더 이상 이러한 장치 내에서 양호한 품질의 이미지를 얻기에 충분하지 않다. 최신의 렌즈 조립체 설계는, 예를 들면 US 제8,395,851호에서는, 5개의 렌즈 요소들을 사용한다. 그러나, US 제8,395,851호에서의 설계는, TTL 및 유효 초점 길이(EFL) 사이의 비율이 너무 크다는 사실로부터 적어도 문제점을 갖는다.

[0005] 그러므로, 당 업계에서는, 기존의 렌즈 조립체보다 작은 TTL/EFL 비율을 제공하고, 그리고 더 나은 이미지 품질을 제공할 수 있는 5개의 렌즈 요소의 광학 렌즈 조립체를 위한 필요성이 존재한다.

[이 사건 특허명세서 중 해당 부분 발췌]

---

[1] 피고가 제출한 자료 중 이 사건 특허발명의 우선일 전에 공개된 휴대 단말기용 소형 망원 렌즈 조립체는 선행발명 1(을 제4호증) 하나에 불과합니다. 원고가 파악하고 있는 현황도 별반 다르지 않습니다.

[2] 휴대 단말기에 광각 카메라가 적용된 시기는 1990년대 후반이고, 휴대 단말기용 망원 카메라가 실제로 적용된 시기는 2017년 하반기입니다. 이와 같이 휴대 단말기에 망원 카메라가 적용되기까지 약 20 년이 소요되었다는 사실은 이 사건 특허발명의 기술적 우수성을 잘 보여줍니다.

휴대 단말기에 적용되는 망원 렌즈 조립체가 짧은 총 트랙길이(TTL)라는 제약된 환경 하에서 충분한 이미지 품질을 얻기 위해서는 종래의 일반 카메라용 망원 렌즈 조립체와는 다른 새로운 구조와 형태가 필요하였습니다.[3] 이를 위해 이 사건 특허발명은 ① 짧은 총 트랙길이를 가지고(TTL≤6.5mm), ② 총 트랙길이보다 긴 초점거리(EFL)를 가지며, ③ 제1 렌즈요소의 굴절력을 크게(f1<TTL/2)하고, ④ F#를 2.9 미만으로 하는 새로운 구성을 채택하였습니다(2020.11.25자 원고 준비서면 2면 이하 참고).

나. TTL의 상한, F#의 상한 및 제1렌즈요소의 양의 굴절력과 TTL의 관계에 관하여

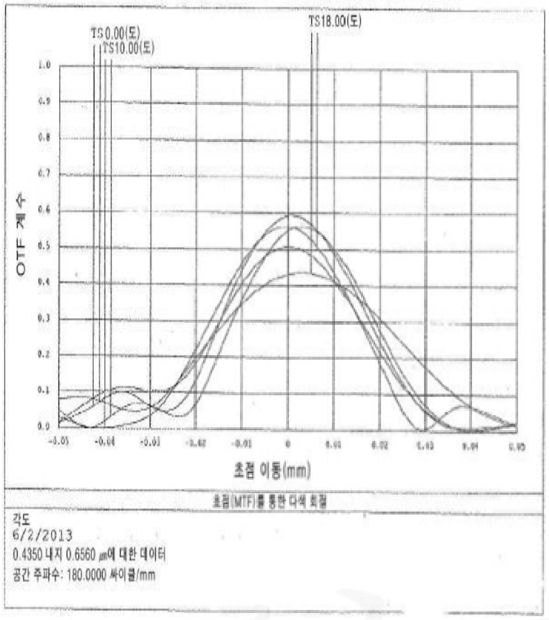
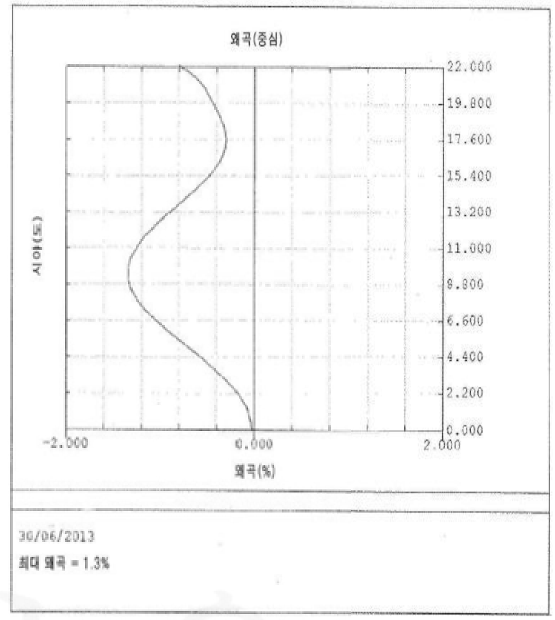
TTL < 6.5mm, TTL/EFL ≤ 1, F# < 2.9, f1 < TTL/2 구성과 관련하여, ① TTL의 상한 6.5mm(TTL < 6.5mm 구성 관련)는 휴대용 단말기의 두께에 따른 렌즈 조립체의 한계와 관련되고, ② F#의 상한 2.9는 렌즈 조립체의 최대 입사 광량과 관련되며, ③ 제1 렌즈요소의 양의 굴절력이 커질수록 TTL이 줄어드는 상관관계가 있습니다.

그런데 진보성 판단에 있어 위 각 구성이 선행발명에 개별적으로 개시되었는지 여부를 고려하여서는 안되고, 위 각 구성이 유기적으로 결합된 발명 전체를 기준으로 진보성 여부를 판단하여야 합니다.

이 사건 제1항 정정발명은 TTL < 6.5mm, TTL/EFL ≤ 1, F# < 2.9, f1 < TTL/2 등의 구성이 **유기적으로 결합됨으로써** 휴대 단말기용 소형 망원 렌즈 조립체에서 높은 이미지 화질을 얻을 수 있고, 상기 얻어진 이미지의 왜곡 오차가 인간의 눈으로는 인식 불가능한 2% 이내인 양질의 이미지를 얻을 수 있는 것입니다. 이는 이 사건 특허 도면 1b, 1c 및 도면 2b, 2c, 도면 3b, 3c 등에서도 확인됩니다. 대표적으로 도면 1b, 1c는 아래와 같습니다.

(도면 1b)	(도면 1c)

[3] 통상의 일반 카메라용 망원 렌즈 조립체를 그대로 축소할 경우, 필름에 해당하는 촬상 소자의 면적이 극히 좁아져서 양호한 이미지를 얻을 수 없습니다(2021.05.25. 자 원고 준비서면 19-20면 참고). 이는 피고가 제출한 을 제6호증의1에도 명확하게 기재되어 있습니다.

<table>
<tr>
<td>
</td>
<td>
</td>
</tr>
<tr>
<td>센서의 각 부분 별로, 초점 위치(0mm) 근처에서 최대의 OTF계수값[4]을 가지므로, 이미지가 선명함</td>
<td>이미지 왜곡이 사람의 시각이 인지할 수 있는 2% 보다 작은 최대 1.5%를 나타냄</td>
</tr>
</table>

다. 통상의 기술자는 현재 'TTL의 하한'을 어느 정도로 보는지에 관하여

아래 표와 같이 이 사건 특허발명의 우선일(2013.07.04.) 당시 휴대 단말기 두께의 하한은 6.5㎜ 이상이었습니다. 휴대 단말기의 작동을 위한 부품 기술 발전 및 광각과 망원 렌즈 조립체에 장착되는 렌즈 개수 등을 고려하면, 현재 휴대 단말기의 두께(또는 TTL의 최대 하한)은 4.5㎜~5㎜로 예상됩니다.

[이 사건 특허발명의 우선일 당시 휴대 단말기 제조사별 휴대 단말기의 두께 정리표]

---

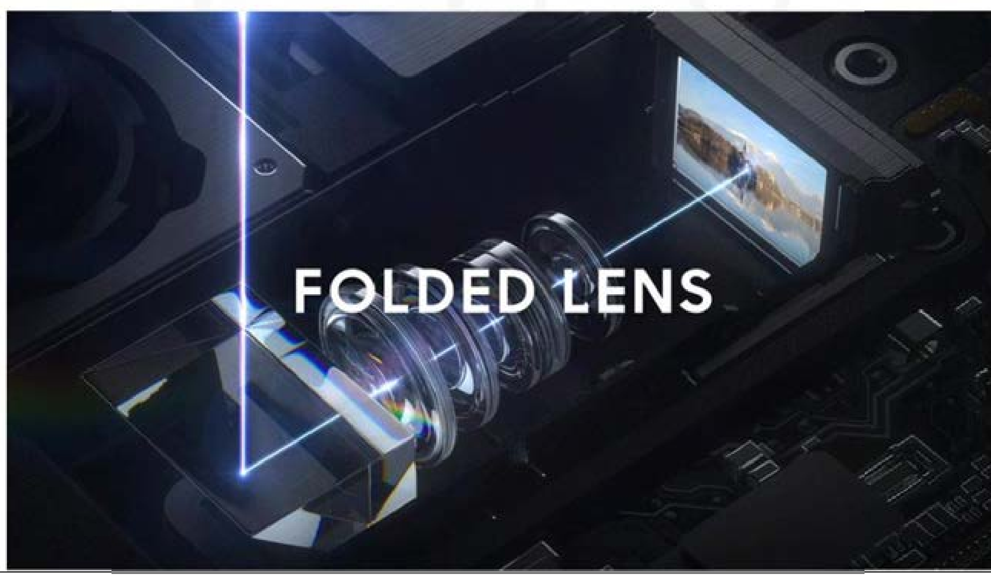
[4] OTF는 optical transfer function의 약자로 렌즈 등의 광학계가 가진 공간 주파수 전송능력을 나타내는 함수로서 해상력을 표시하는 방법을 말합니다(참고자료 1. 과학백과사전 레스폰스함수 검색화면)

제조사	모델명	공개일	스마트폰 두께	비고
OPPO	X907	2012.06	6.65 mm	참고자료 2
후지쯔	Arrows ES IS12F	2012.01	6.7 mm	참고자료 3
화웨이	Ascend P1s	2012.01	6.68 mm	참고자료 4
애플	아이폰 5	2012.09	7.6 mm	참고자료 5
삼성전자	갤럭시 S4	2013.03	7.9 mm	참고자료 6
SONY	엑스페리아 Z 울트라	2013.06	6.5 mm	참고자료 7

최근에는 렌즈의 배치 방향을 휴대 단말기의 두께 방향에서 폭 방향으로 직각으로 꺾어 배치하는 방식이나, 카메라 수를 증가시키는 방식을 채택하여 휴대 단말기 두께로 인한 한계를 극복하는 기술이 개발되고 있습니다.

참고자료 8. 삼성홈페이지 폴디드 렌즈 화면

렌즈의 경우 수직 구조로 공간을 더 필요로 하기 때문에 카메라가 두꺼워지지만, 폴디드 렌즈는 잠망경 원리와 같이 프리즘을 사용한 방식이기 때문에 스마트폰 카메라 바닥에 평평하게 자리 잡을 수 있었던 것. 스마트폰 뒷면을 통해 들어오는 빛이 프리즘에 의해 렌즈로 전달되면, 폰 내부에 렌즈의 구조를 가로로 정렬한 폴디드 렌즈가 이를 다시 90도로 굴절 시켜 초점 거리를 늘린다. 이렇게 카메라의 높이와 넓이가 줄어들어 갤럭시 S20 울트라의 혁신적인 줌 성능이 구현된다.



현재 통상의 기술자가 예상하는 휴대 단말기의 두께(TTL의 하한으로서 4.5㎜~5㎜)를 고려해볼 때 “이 사건 특허의 상세한 설명은 TTL이 0에 근접한 값(0.1mm 이하) 및 F#가 0에 근접한 값(10^{-3} 이하)을 쉽게 실시할 수 있을 정도로 기재되어 있지 않다”

는 이 사건 심결의 판단(또는 채권자 주장)은 이 사건 특허발명의 기술적 의의를 잠식시키는 극단적인 경우들을 상정한 것으로서 전혀 타당하지 않습니다.[5]

라. 이 사건 제1항 정정발명의 TTL의 상한 6.5㎜ 와 F#의 상한 2.9 구성은 어떻게 정해진 수치인지에 관하여

휴대 단말기에 장착되는 소형 망원 렌즈 조립체는 어느 두께(TTL의 길이)의 소형 휴대 단말기에 장착되는지 여부가 매우 중요한 고려사항이고, 이는 TTL의 길이의 별다른 제한이 없는 일반 렌즈 조립체와 다릅니다. 또한 소형 망원 렌즈 조립체는 고화질의 구현을 위한 많은 광량을 제공할 수 있는지 여부가 중요한 고려사항인데 이는 종래의 짧은 초점거리를 갖는 광각 렌즈 조립체에서는 광량 부족이 발생하지 않아 별 문제가 안되는 사항입니다. 즉 소형의 휴대 단말기에 장착되는 망원 렌즈 조립체에서는 TTL과 F#의 수치는 그 상한에 그 기술적 의의가 있습니다.

이 사건 특허발명 출원 당시(2013년경)에는 휴대 단말기에 망원 렌즈 조립체를 장착하는 기술은 거의 없었고, 이 사건 특허발명의 발명자들은 소형의 휴대 단말기에 장착하여 양질의 이미지를 얻을 수 있는 소형 망원 렌즈 조립체를 연구한 결과 최적의 TTL의 상한 및 F#의 상한을 도출한 것입니다.

TTL의 수치범위는 이 사건 특허의 상세한 설명의 'TTL은 EFL보다 작[다]'는 기재[6]와 실시예의 TTL값을 통해 도출할 수 있습니다.

즉 TTL < EFL 및 EFL = 6.90mm(실시예 1), 7mm(실시예 2), 6.84mm(실시예 3) 등의 실시예에서 적어도 TTL < 7mm 에서 충분히 양질의 이미지를 얻을 수 있었습니다. 또한 실시예에서는 이보다 더 얇은 TTL= 5.904mm(실시예 1), 5.90mm(실시예 2), 5.904mm(실시예 3)에서도 양호한 이미지를 얻을 수 있음을 확인한 후, 다른 구성요소들과 유기

[5] 특허법원 2018. 8. 30. 선고 2018허2700 판결은 "이 사건 특허발명의 기술적 의의를 잠식시키는 극단적인 경우들을 상정하여 그 실시까지 가능하도록 발명의 설명에 기재되어 있을 것을 요구할 수도 없다"고 판시하였습니다.

[6] 갑 제3호증 단락 [0009]

적으로 결합하는 경우에도 충분히 양호한 이미지를 얻을 수 있도록 'TTL의 상한을 7mm보다 작은 6.5mm로 줄여 한정한 것입니다.[7]

F#와 관련해서는, F#<2.9 조건은 '렌즈 조립체는 F 번호, F#<3.2를 갖는다'는 기재(갑 제3호증 단락 [0009]) 및 (TTL이 6.5mm 이하이고 TTL/EFL이 1보다 작은 휴대 단말기의 소형 망원 렌즈 조립체에서 양호한 이미지 품질을 얻을 수 있는 충분한 광량을 얻기 위한 실시예로서) F#= 2.80(실시예 1), 2.86(실시예 2), 2.80(실시예 3)을 통해 도출된 것입니다. 한편 휴대 단말기에 사용되는 이미지 센서는 크기에 제한이 있으므로 제한된 면적 조건 하에서 해상도를 향상시키기 위해 이미지 센서의 화소수를 늘리는 경우에도[8] 충분한 광량을 확보할 수 있도록 F#의 상한을 3.2보다 작은 2.9로 한정한 것입니다.

마. 렌즈 분야의 기술 상식에 비추어 TTL을 더 작게 하는 것과 F#를 더 작게 하는 것이 기술과제인지 여부

휴대 단말기용 망원 렌즈 조립체는 일반 망원 카메라와 그 기술사상에 있어서 많은 차이가 있었기 때문에, 이 사건 특허발명 출원 당시에는 통상의 기술자는 휴대 단말기에 망원 렌즈 조립체를 설치할 수 있다는 생각을 하지 못하였습니다. 따라서 당시 통상의 기술자는 휴대 단말기용 망원 렌즈 조립체를 개발하기 위한 기술적 과제로서 '작은 TTL을 가지면서 TTL을 EFL보다 더 작게 하고 동시에 F#를 작게 하는 기술적 과제'를 전혀 인식하지도 못하였습니다.

통상의 기술자는 이 사건 특허발명 출원 당시 '휴대 단말기에 설치할 수 있는 작은 TTL을 가지면서, TTL을 EFL보다 더 작게 하고 F#를 작게 한' 휴대 단말기의 망원 렌즈 조립체가 이 사건 특허발명의 도면 1b, c 및 도면 2b, c, 도면 3b, c와 같은 양호

[7] 이는 이 사건 특허발명이 휴대단말기 등에 사용된다는 의미함과 동시에, **일반적인 망원 카메라와 달리** 두께가 매우 얇은, 즉 이 사건 특허발명의 우선일 당시 휴대 단말기의 두께(6.5㎜ 이상)에 충분히 장착할 수 있는 망원 렌즈 조립체임을 나타내는 것입니다.

[8] 개별 화소의 크기는 작아지게 됩니다.

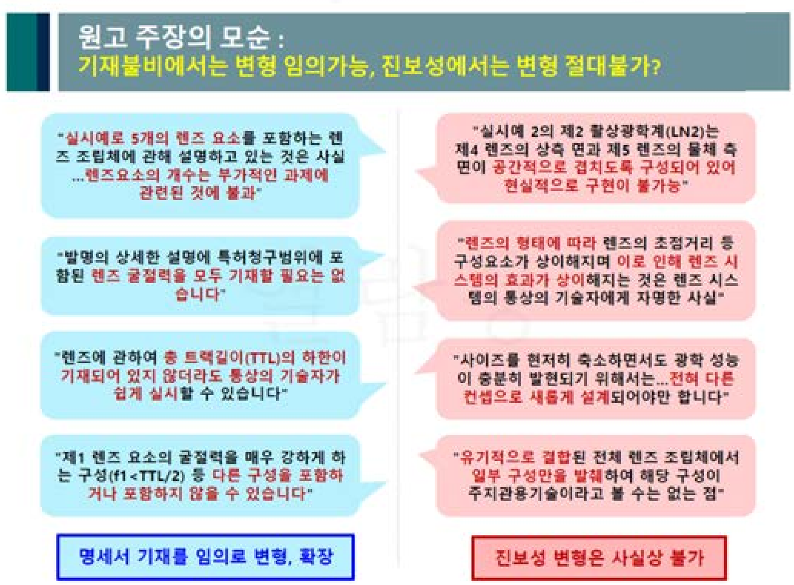
한 이미지를 얻을 수 있는 것도 예측할 수 없었습니다.

휴대 단말기용 망원 렌즈 조립체가 일반화된 현재를 기준으로 '휴대 단말기에 설치할 수 있는 작은 TTL을 가지면서, TTL을 EFL보다 더 작게 하고 F#를 더 작게 하는 것'이 이 분야의 일반적인 기술 과제라고 본다면 이는 통상의 기술자가 이 사건 특허의 명세서에 개시된 기술을 알고 있음을 전제로 사후적으로 판단한 것으로 전형적인 사후적 고찰입니다.

3. 피고 주장에 대한 반박

가. 기재불비와 진보성 부분에 대한 원고 주장에는 아무런 모순이 없습니다.

피고는, 원고 주장은 진보성 부분에서는 통상의 기술자가 렌즈 조립체의 구성을 임의로 변경할 수 없는 반면 기재불비 부분에서는 렌즈 조립체의 구성을 임의로 변경할 수 있다는 것으로 서로 모순된다고 주장합니다(2021. 6. 10.자 피고 변론자료 70면).



[2021. 6. 10.자 피고 변론자료 70면]

그러나 피고 주장은 전혀 이유 없습니다.

용이 실시 가능성(기재불비 관련)은 통상의 기술자가 **특허발명의 명세서의 기재와 출원 당시의 기술수준**을 참고하여 청구항에 기재된 발명을 쉽게 실시할 수 있는지 여부를 판단하는 것입니다. 따라서 통상의 기술자라면 출원 당시의 기술수준과 이 사건 특허의 명세서의 기재를 참고하여 이 사건 특허발명이 제안하는 핵심구성을 바탕으로 나머지 렌즈 구성을 변경하는 것은 기술적으로 어렵지 않습니다.

반면 **구성의 곤란성 여부(진보성 관련)는** 통상의 기술자가 이 사건 특허발명의 구성을 알지 못하는 상태에서 출원 당시의 **선행발명으로부터** 특허발명의 구성을 도출하는 것이 쉬운지 여부를 판단하는 것입니다. 그런데 이 사건 특허발명과 선행발명들은 그 기술사상에 있어서 근본적인 차이가 있고 구체적인 구성도 다르기 때문에 통상의 기술자가 선행발명들로부터 (또는 선행발명의 구성을 변경하여) 이 사건 특허발명의 구성의 전부 또는 일부를 도출할 수 없습니다.

따라서 원고 주장은 전혀 모순되지 않습니다.

나. 이 사건 특허발명은 발명의 상세한 설명에 의하여 뒷받침되지 않는다는 피고의 주장은 이유 없습니다.

(1) 피고는 이 사건 특허의 상세한 설명에 5개 렌즈 요소의 굴절력 조합(양/음/음/양/음)을 특정하여 기재하고 있으므로, 이와 다른 조합의 렌즈 조립체의 구성은 발명의 상세한 설명에 뒷받침되지 않는다고 주장합니다(2021. 5. 28.자 피고 준비서면 3 내지 5면).

그러나 위 피고 주장도 모두 이유 없습니다.

(2) 렌즈 매수와 관련하여, 이 사건 특허발명의 기술적 과제는 5개 렌즈 요소의 굴절력 조합으로 한정된 것이 아니라, 두께가 얇으면서도 양호한 이미지를 얻을 수 있는 (더 작은 TTL/EFL 비율을 갖는) 휴대 단말기용 소형 망원 렌즈 조립체를 제공하는 것입니다(자세한 내용은 2021. 2. 18.자 원고 준비서면 3 내지 17면 참고)

이 사건 특허의 상세한 설명은 4개의 렌즈요소를 초과하는 경우에도 두께가 얇으

면서 양호한 이미지를 얻을 수 있는 소형 망원 렌즈 조립체가 필요하다고 기재하고 있으며(갑 제3호증 단락 [0004], [0005]), 반드시 5개의 렌즈요소의 광학렌즈 조립체로 한정하고 있지 않습니다.

또한 이 사건 특허발명은 '해결하려는 과제'로 종래의 문제점을 해결할 수 있는 소형 망원 렌즈 조립체를 제공함에 그 목적이 있다고 기재할 뿐, 렌즈 요소의 개수를 한정하고 있지 않습니다(갑 제3호증 단락 [0006]).

나아가 이 사건 특허발명은 '실시예'로서 개방형 청구항 형식인 '제5 렌즈요소들을 포함'하는 광학렌즈 조립체를 기재하고 있으므로(갑 제3호증 단락 [0007]) 렌즈요소를 5개로 한정하는 것이 아닙니다.

한편 피고 주장은 발명의 상세한 설명에 실시예로 기재된 렌즈 조립체의 모든 구성을 독립항에 기재해야 한다는 것인데, 이는 발명을 독립항과 종속항으로 나누어 기재할 수 있다고 규정하고 있는 특허법 규정[9] 및 '특허청구범위에 기재된 구성이 반드시 발명의 상세한 설명이나 도면에 기재되어 있어야 하는 것은 아니다'라고 판시한 대법원 판결(대법원 2006. 11. 24. 선고 2003후2072 판결[10])에 반합니다.

피고 자신도 발명의 상세한 설명에 일 실시예로 기재된 발명을 특허청구범위에 세분화하여 기재한 특허를 다수 등록 받은 바 있습니다.[11]

(3) 굴절력 조합과 관련하여, 이 사건 특허발명의 출원 당시의 기술 수준 및 이 사건 특허명세서의 기재들을 고려해보면, 이 사건 제35항 발명의 '음의 광학력을 함께 갖는 한 쌍의 제2 및 제3 렌즈 요소들'에 대응되는 사항은 이 사건 특허의 상

[9] 특허법 시행령 제5호제1항

[10] "이 사건 특허발명이 모두 청구항에 명시적으로 기재된 구성요소 외에 다른 기술들을 추가하여 실시할 수 있는 기재형식을 취하고 있는 이상, 이 사건 제17항 내지 제22항 발명의 실시예에 관한 상세한 설명이나 도면이 청구항에는 기재되어 있지 아니한 '단어와 조사를 분리하는 단계'를 추가하여 보여주고 있다고 하더라도 그러한 사정만으로 위 제17항 내지 제22항 발명이 상세한 설명에 의하여 뒷받침되지 않는다고 할 수 없을 것이다."

[11] 갑 제10호증 및 제11호증 각 등록특허공보 및 2021.02.18. 자 원고의 준비서면 4 내지 6면 참조

세한 설명 및 도면에 기재되어 있거나 통상의 기술자가 이 사건 명세서 기재로부터 충분히 인식 가능합니다(2021. 2. 18.자 원고 준비서면 9 내지 10면).

구체적으로, 이 사건 특허의 상세한 설명에는 "제3 및 제4 렌즈요소들 사이의 비교적 긴 거리와 제4 및 제5 렌즈요소들의 조합된 설계는 이미지 면에 모든 시야의 초점들을 가져오는 데에 도움을 준다"는 기재(갑 제3호증 단락 [0011]), "양의 굴절력을 갖는 제1 렌즈요소의 초점 길이 f1 이 TTL/2 보다 작다"는 기재(갑 제3호증 단락 [0009])가 있습니다.

이는 양의 굴절력(즉, 수렴렌즈)을 갖는 제1 렌즈요소를 통과하면서 한 점으로 강하게 집광되도록 굴절된 광은 제2 렌즈요소와 제3 렌즈요소를 통과한 뒤에 상대적으로 긴 거리를 지나(즉, 제3 및 제4 렌즈요소들 사이의 긴 거리) 제4 렌즈요소를 통과해야 함을 의미합니다.

즉 빛이 제3 및 제4 렌즈요소들 사이의 긴 거리를 지나 제4 렌즈요소에 도달하기 위해서는 **제2 렌즈요소와 제3 렌즈요소는 빛을 퍼뜨려 주는 오목 렌즈(음의 굴절력)의 기능을 필수적으로 수행해야 함**을 통상의 기술자라면 누구나 쉽게 파악할 수 있습니다.

또한 제2 렌즈요소의 f2, 제3 렌즈요소의 f3이 각각 양의 값 또는 음의 값을 가질 수 있다는 것은 이 사건 특허의 상세한 설명에서 '최소 색수차는 조건 1.2x｜f3｜>｜f2｜>1.5xf1 을 충족함으로써 얻어'진다고 하여 절대값으로 표기하고 있는 기재와도 정확하게 일치합니다(갑 제3호증 단락 [0010]).

다. 특허청구범위에 TTL과 F# 값의 하한이 기재되어 있지 않아도 통상의 기술자는 이 사건 정정발명을 실시할 수 있습니다.

피고는 수치범위의 상한 또는 하한을 설정하지 않을 경우, 통상의 기술자가 청구범위에 기재된 발명을 쉽게 실시할 수 없다고 주장합니다(2021. 5. 28.자 피고 준비서면 7 내지 10면).

그러나 위 피고 주장도 이유 없습니다.

우선 본건 통상의 기술자는 '렌즈 조립체 기술 분야의 석사과정을 마치고, 2~3년 정도의 업계 경력을 가진 자'로 상정할 수 있습니다.

그런데 통상의 기술자가 TTL 또는 F# 의 하한이 기재되어 있지 않다고 하여 관련 렌즈 조립체 발명을 실시할 수 없다는 피고 주장은 억지스러운 주장입니다.

앞서 설명드린 바와 같이 이 사건 특허발명의 기술적인 의의는 TTL 및 F#의 상한에 있는 것이고, TTL의 하한, F#의 하한 등은 휴대 단말기의 두께나 광량 등의 물리적 한계가 있어 통상의 기술자가 필요에 따라 쉽게 설정할 수 있습니다.

따라서 기술적으로 중요한 수치의 상한이 기재되어 있는 이상 통상의 기술자는 이 사건 특허발명을 당연히 실시할 수 있습니다.[12]

유사 사례로서 세계 각국 특허청은 청구범위에 TTL이나 F# 의 하한의 구성을 기재하지 않은 경우도 실시 가능한 것으로 보고 있습니다(갑 제9호증, 제28호증 내지 제34호증).

만일 피고 주장대로 실시 가능한 모든 수치범위를 기재하여야 한다면, 발명자는 의미 없는 수치 하한을 찾기 위해 불필요한 실험을 다수 수행하여야 하는 부당한 결론에 이르게 됩니다.[13]

라. 이 사건 특허발명의 TTL 또는 F# 수치범위는 발명의 상세한 설명에 의해 뒷받침됩니다.

피고는 이 사건 특허발명에 TTL의 수치범위(TTL ≤ 6.5mm)와 F# 수치범위(F# < 2.9)

[12] 특허법원 2013. 1. 25. 선고 2012허6700 판결도 기술적으로 중요한 수치의 상한 또는 하한만을 특정하면 충분한 것이고, 기술적으로 중요하지 않은 하한 또는 상한이 특정되지 않았다고 해서 발명이 불명확하다고 볼 수는 없다고 판시하였습니다.

[13] 실제로 그러한 (의미 없는) 수치의 하한에서 임계적 의의가 있는 것인지 여부도 확인이 불가능할 수 있습니다.

의 각 하한이 기재되어 있지 않아 뒷받침 요건 결여의 기재불비 사유가 있다고 주장합니다(2021. 5. 28.자 피고 준비서면 6면).

그러나 위 피고 주장 역시 이유없습니다.

대법원은 "청구항이 발명의 상세한 설명에 의하여 뒷받침 되는지는 통상의 기술자의 입장에서 특허청구범위에 기재된 사항과 대응되는 사항이 발명의 상세한 설명에 기재되어 있는지 여부에 의하여 판단하여야 한다"고 일관되게 판시하고 있습니다(대법원 2014. 9. 4. 선고 2012후832 판결).

그런데 휴대 단말기용 렌즈 시스템을 설계하는 통상의 기술자는 TTL의 상한으로부터 이 사건 특허발명이 두께가 매우 얇은 소형의 휴대 단말기 등에 적용되는 것임을 바로 인식할 것이고, F#의 상한 또한 휴대 단말기용 소형 망원 렌즈 조립체에서 양호한 이미지 품질을 얻기 위한 충분한 광량을 요구한다는 의미를 쉽게 파악할 수 있습니다.

구체적으로 2021. 2.18.자 원고의 준비서면 26면 및 이 참고서면 6 내지 7면 2. 라.에서 설명드린 바와 같이 'TTL≤6.5mm' 구성은 이 사건 특허의 상세한 설명의 'TTL은 EFL보다 작[다]'는 기재(갑 제3호증 단락 [0009]), 각 실시예의 EFL값(6.90mm, 7mm, 6.84mm), 각 실시예의 TTL값(5.904mm, 5.90mm, 5.904mm)을 통해 도출된 것입니다. 따라서 이 사건 정정발명 청구범위는 발명의 상세한 설명의 범위 내에서 한정한 것으로서, 발명의 상세한 설명에 대응되는 구성이 기재되어 있으므로 발명의 상세한 설명에 의하여 충분히 뒷받침되는 구성에 해당합니다.

나아가 F#의 수치범위에 대하여도, '렌즈 조립체의 F#는 2.9보다 작은 구성'은 이 사건 특허발명의 과제 해결 수단의 '렌즈 조립체는 F 번호, F# < 3.2를 갖는다'는 기재(갑 제3호증 단락 [0009]) 및 각 실시예의 F#값(2.80, 2.86, 2.80)을 통해 도출된 것입니다. 위 구성은 이 사건 특허의 상세한 설명에 기재된 수치범위 내에서 고화질의 구현을 위한 많은 광량을 충분히 제공할 수 있도록 그 수치범위를 좁게 한정한 것이므로, 문언적으로도 발명의 상세한 설명에 뒷받침됩니다.

또한 특허청구범위에 청구항으로 기재된 사항은 발명의 설명에 개시한 발명 중 출원인이 스스로의 의사로 특허권으로 보호받고자 하는 사항으로 선택하여 기재한 사항이라고 규정한 특허청 심사기준[14]이나, 특허청구범위에 어떠한 구성요소를 기재할지 여부는 출원인이 자유롭게 결정할 수 있다는 판결[15]에 비추어 보더라도, 이 사건 특허의 상세한 설명에 기재된 수치범위 내에서 선택된 이 사건 특허발명의 청구범위는 발명의 상세한 설명에 뒷받침됩니다.

특허·실용신안 심사기준은 청구범위가 발명의 상세한 설명에 의해 뒷받침되는지 여부에 대하여 해당 기술분야에서 통상의 지식을 가진 자가 발명의 설명으로부터 파악할 수 있는 범위를 벗어난 발명을 청구항에서 청구하고 있는 것은 아닌지를 중점적으로 검토하여 판단한다고 기재하고 있습니다.

갑 제35호증 특허 실용신안 심사기준(개정 2020. 12. 14. 특허청 예규 제117호)

14

갑제 35호증 하단 페이지 기준 2402면 '2. 발명의 인정' 부분 참조
청구범위에 청구항으로 기재된 사항은 특허법 제42조제4항 및 제8항의 청구범위 기재방법에 따라 발명의 설명에 개시한 발명 중 출원인이 스스로의 의사로 특허권으로 보호를 받고자 하는 사항으로 선택하여 기재한 사항이다.

15

특허법원 2009. 12. 24 선고 2009허4742 판결
특허발명의 청구항에 '발명의구성에 없어서는 아니 되는 사항만으로 기재될 것'을 요구하는 구 특허법 제42조 제4항제3호는 출원발명에 대한 특허 후에 그 특허청구범위에 발명의 구성에 필요한 구성요소를 모두 기재하지 아니하였음을 들어 특허 당시 기재되어 있지 아니하였던 구성요소를 가지고 원래 기재되어 있던 듯이 포함하여 해석하여야 한다고 주장할 수 없음은 물론, 청구항에 기재된 구성요소는 모두 필수구성요소로 파악되어야 하며 일부 구성요소를 그 중요성이 떨어진다는 등의 이유로 필수구성요소가 아니라고 주장할 수 없다는 것을 확인하는 것으로 보아야 할 뿐(대법원 2006. 11. 24. 선고 2003후2072 판결 참조), 그 특허발명의 목적과 효과 달성에 필요한 모든 구성을 특허청구범위에 기재할 것을 요구하는 규정으로 볼 수 없고, 특허청구범위에 어떠한 구성요소를 기재할 지 여부는 출원인이 그 발명의 기술적 범위를 좁게 할 것인지, 넓게 할 것인지 등을 고려하여 자유롭게 결정할 수 있다고 할 것이며, 특허발명의 목적과 효과 달성에 필요한 것으로 보이는 구성요소 일부를 특허청구범위에 기재하지 아니한 경우 그로 인하여 미완성 발명이 되거나 진보성을 결여하는 등의 이유로 특허등록을 받을 수 없는 것은 별론으로 하고, 이를 들어 구 특허법 제42조 제4항제3호에 위반되어 특허등록을 받을 수 없다고 할 수는 없다.

대응되는 사항이 발명의 설명에 기재되어 있는지는, 청구항과 발명의 설명의 문언상 동일 여부보다는 제42조제4항제1호의 취지를 고려하여 해당 기술분야에서 통상의 지식을 가진 자가 발명의 설명으로부터 파악할 수 있는 범위를 벗어난 발명을 청구항에서 청구하고 있는 것은 아닌지를 중점적으로 검토하여 판단한다.

나아가 특허법원은 "특허발명의 명세서에 특허청구범위를 뒷받침하는 모든 실시예를 기재하여야 하는 것은 아니므로 사방확정 관련 실시예가 기재되어 있지 않다 하더라도 이를 이유로 기재불비라 할 수는 없다"고 판시하였습니다(특허법원 2011. 8. 10. 선고 2011허620 판결).

따라서 이 사건 특허발명의 TTL 또는 F# 수치범위는 발명의 상세한 설명에 충분히 뒷받침되고 이에 반하는 피고 주장은 이유 없습니다.

마. 이 사건 특허발명의 TTL 또는 F# 수치범위는 청구범위에 명확하고 간결하게 기재되어 있습니다.

피고는 TTL 또는 F# 수치범위는 하한이 없으므로, 특허청구범위가 명확하고 간결하게 기재되어 있지 않다고 주장합니다(2021. 5. 28.자 피고 준비서면 10, 11면).

그러나 이 사건 특허발명은 수치범위의 하한이 기재되어 있지 않다는 이유로 이 사건 특허발명에 기재불비의 무효사유가 있다고 볼 수 없습니다.

앞에서 설명 드린 바와 같이, 이 사건 특허발명은 TTL 및 F#의 상한에 기술적 따라서 통상의 기술자는 이 사건 특허발명에 TTL 및 F#의 하한의 기재가 없더라도 TTL 및 F#의 상한값으로 이 사건 특허발명을 명확하게 파악할 수 있습니다.

더욱이 이 사건 특허발명은 TTL과 F#의 상한을 한정하여 오히려 이 사건 특허발명의 권리범위를 TTL과 F#에 대하여 더욱더 좁은 범위로 한정한 것으로서, 이러한 수치범위로 인해 종래 기술에 비하여 **발명이 불명확하게 되는 것이 아닙니다.**

따라서 위 피고 주장도 이유 없습니다.

바. 이 사건 특허발명에는 신규사항 추가의 무효사유가 없습니다.

피고는 이 사건 특허발명의 'TTL 수치범위'와 'F# 수치범위', 그리고 '제2 및 제3 렌즈 요소의 합성 굴절력 구성'은 출원경과 중에 보정에 의해 추가된 구성이므로, 신규사항 추가에 해당한다고 주장합니다(2021. 5. 28.자 피고 준비서면 11면).

그러나 위 피고 주장은 이유 없습니다.

이 사건 특허발명의 TTL과 F#는 우선권출원 명세서에 기재된 사항의 범위 내에 있습니다.

구체적으로 우선권출원 명세서 2면 11-13행에는 'TTL is smaller than the EFL'는 'and' 라는 접속 조사와 함께 'the TTL/EFL ratio is smaller than 0.9'와 병행하여 기재되어 있습니다.

The effective focal length of the lens assembly is marked EFL and the total track length on an optical axis between the object-side surface of the first lens element and the electronic sensor is marked TTL. In all embodiments, TTL is smaller than the EFL and the TTL/EFL ratio is smaller than 0.9. In an embodiment, the TTL/EFL ratio

[을 제7호증 2면]

우선권출원 명세서는 'TTL < EFL'및 'TTL/EFL < 0.9'를 모두 포함하고 있으므로 우선권 출원 원문은 'TTL/EFL < 1.0 을 명시적으로 개시하고 있는 것입니다.

한편 우선권출원 명세서에도 EFL 수치들(6.9 mm, 7 mm, 6.84 mm)[16], TTL/EFL < 1.0 구

16

을 제7호증 6, 8, 10면
Embodiment **100** provides a field of view (FOV) of 44 degrees, with EFL = 6.90 mm, F# = 2.80 and TTL of 5.904 mm. Thus and advantageously, the ratio TTL/EFL = 0.855. Advantageously, the Abbe number of the first, third and fifth lens element is

성이 기재되어 있으므로 TTL ≤ 6.5mm도 위 수치범위 내의 구성입니다.

특허출원서에 최초로 첨부된 특허청구범위를 보더라도 청구항 10은 "렌즈 조립체는 3.2보다 작은 F 번호를 갖는 것"이라고 기재하고 있고(을 제3호증의1 22면), 상세한 설명도 "F# < 3.2" 및 각 실시예 "F#= 2.80, 2.86, 2.80"을 제시하고 있으므로(갑 제3호증 [0009], [0020], [0026], [0032]) , F# < 2.9는 특허출원서에 최초로 첨부된 특허청구범위의 수치범위 내의 것임이 명백합니다.

【청구항 10】 제1항에 있어서, 상기 렌즈 조립체는 3.2보다 작은 F 번호를 갖는 것임을 특징으로 하는 광학 렌즈 조립체.

[을 제3호증의1 22면]

[0009]	TTL은 제1 렌즈 요소의 물체-측 표면과 이미지 센서 사이의 광축 상의 거리로 정의된다. "EFL"는 그것의 통상적인 의미를 갖는다. 모든 실시 예에서, TTL은 EFL보다 작으며, 즉 TTL/EFL 비율이 1.0보다 작다. 일부 실시 예에서, TTL/EFL 비율은 0.9 미만이다. 일 실시 예에서, TTL/EFL의 비율은 대략 0.85이다. 모든 실시 예에서, 상기 렌즈 조립체는 F 번호, F#<3.2를 갖는다. 일 실시 예에서, 제1 렌즈 요소의 초점 길이 f1는 TTL/2보다 작고, 제
[0020]	실시 예(100)는 EFL = 6.90 mm, F# = 2.80 및 5.904 mm의 TTL을 갖는 44도(°)의 시야(FOV)를 제공한다. 따라
[0026]	실시 예(200)는 43.48° 의 FOV, EFL = 7mm, F# = 2.86 및 TTL = 5.90mm를 제공한다. 따라서 바람직하게는, 비
[0032]	실시 예(300)는 44° 의 FOV, EFL = 6.84 mm, F# = 2.80 및 TTL = 5.904 mm를 제공한다. 따라서 바람직하게는,

[갑 제3호증 단락 [0009], [0020], [0026], [0032]]

Embodiment **200** provides a FOV of 43.48 degrees, with EFL = 7 mm, F# = 2.86 and TTL = 5.90mm. Thus and advantageously, the ratio TTL/EFL = 0.843.
Embodiment **300** provides a FOV of 44 degrees, EFL = 6.84 mm, F# = 2.80 and TTL = 5.904 mm. Thus and advantageously, the ratio TTL/EFL = 0.863. Advantageously,

우선권출원 명세서{을 제7호증 2면 13줄~3면 5줄(원문), 29면 14줄~30면 13줄(번역문)}에도 이 사건 특허의 상세한 설명 단락 [0009] 내지 [0011]에 대응되는 기술내용이 기재되어 있습니다. 따라서 제2 및 제3 렌즈 요소의 합성 굴절력 구성'도 최초 명세서 등에 기재되어 있는 것입니다.

[0009] TTL은 제1 렌즈 요소의 물체-측 표면과 이미지 센서 사이의 광축 상의 거리로 정의된다. "EFL"는 그것의 통상적인 의미를 갖는다. 모든 실시 예에서, TTL은 EFL보다 작으며, 즉 TTL/EFL 비율이 1.0보다 작다. 일부 실시 예에서, TTL/EFL 비율은 0.9 미만이다. 일 실시 예에서, TTL/EFL의 비율은 대략 0.85이다. 모든 실시 예에서, 상기 렌즈 조립체는 F 번호, F#<3.2를 갖는다. 일 실시 예에서, 제1 렌즈 요소의 초점 길이 f1는 TTL/2보다 작고, 제1, 제3 및 제5 렌즈 요소들 각각은 50 이상의 아베 수("Vd")를 갖고, 제2 및 제4 렌즈 요소들 각각은 30보다 작은 아베 수를 가지며, 제1 공기 간격은 d2/2보다 작고, 제3 공기 간격은 TTL/5보다 크고, 제4 공기 간격은 1.5d5보다 작다. 일부 실시 예에서, 상기 렌즈 요소들의 표면은 비구면일 수 있다.

[0010] 여기에 개시된 광학 렌즈 조립체에서, 양의 굴절력을 가진 제1 렌즈 요소는 렌즈 시스템의 TTL이 양호하게 감소될 수 있도록 하여준다. 제1, 제2 및 제3 렌즈 요소들 및 그들 사이의 상대적으로 짧은 거리의 조합 설계는, 긴 EFL과 짧은 TTL을 가능하게 한다. 동일한 조합은 제2 렌즈 요소에 대한 고 분산(저 Vd) 및 제1 및 제3 렌즈 요소에 대한 저 분산(고 Vd)과 함께, 또한 색수차를 줄이는데 도움을 준다. 특히, 비율 TTL/EFL<1.0 및 최소 색수차는 조건 1.2x|f3|>|f2|>1.5xf1을 충족함으로써 얻어지고, 여기서 'f'는 렌즈 요소의 유효 초점 길이이고, 부호 1, 2, 3, 4, 5는 렌즈 요소의 번호를 나타낸다.

[0011] 상기 제3 및 제4 렌즈 요소들 사이의 비교적 큰 거리와, 제4 및 제5 렌즈 요소들의 조합된 설계는 이미지 면에 모든 시야의 초점들을 가져오는 데에 도움을 준다. 또한, 제4 및 제5 렌즈 요소들은 서로 다른 분산을 갖고, 각각 양과 음의 굴절력을 갖기 때문에, 그것들은 색수차를 최소화하는데 도움을 준다.

[갑 제3호증 단락 [0009] 내지 [0011]]

렌즈 조립체의 유효 초점 거리는 EFL로 표시되고, 제1 렌즈 요소의 물체-측 표면과 전자 센서 사이의 광축 상의 총 트랙 거리는 TTL로 표시된다. 모든 실시 예에서, TTL은 EFL보다 작고 TTL/EFL 비율이 0.9보다 작다. 일 실시 예에서, TTL/EFL의 비율은 대략 0.85이다. 모든 실시 예에서, 상기 렌즈 조립체는 F 번호, F#<3.2를 갖는다. 일 실시 예에서, 제1 렌즈 요소의 초점 길이 f1는 TTL/2보다 작고, 제1, 제3 및 제5 렌즈 요소들 각각은 50 이상의 아베 수("Vd")를 갖고, 제2 및 제4 렌즈 요소들 각각은 30보다 작은 아베 수를 가지며, 제1 공기 간격은 $d_2/2$보다 작고, 제3 공기 간격은 TTL/5보다 크고, 제4 공기 간격은 $d_5/2$보다 작다.

일부 실시 예에서, 상기 렌즈 요소들의 표면은 비구면일 수 있다.

여기에 개시된 광학 렌즈 조립체에서, 양의 굴절력을 가진 제1 렌즈 요소는 광학 렌즈 시스템의 TTL이 양호하게 감소될 수 있도록 하여준다. 제1, 제2 및 제3 렌즈 요소들 및 그들 사이의 상대적으로 짧은 거리의 조합 설계는, 긴 EFL과 짧은 TTL을 가능하게 한다. 동일한 조합은 제2 렌즈 요소에 대한 고 분산(저 아베 수) 및 제1 및 제3 렌즈 요소에 대한 저 분산(고 Vd)과 함께, 또한 색수차를 줄이는데 도움을 준다. 특히, 비율 TTL/EFL<0.9 및 최소 색수차는 조건 1.2x | f3 | > | f2 | >1.5xf1을 충족함으로써 얻어지고, 여기서 "f"는 렌즈 요소의 유효 초점 길이이고, 부호 1, 2, 3, 4, 5는 렌즈 요소의 번호를 나타낸다.

【0011】 상기 제3 및 제4 렌즈 요소들 사이의 비교적 큰 거리와, 제4 및 제5 렌즈 요소들의 조합된 설계는 이미지 면에 모든 시야의 초점들을 가져오는 데에 도움을 준다. 또한, 제4 및 제5 렌즈 요소들은 서로 다른 분산을 갖고, 각각 양과 음의 굴절력을 갖기 때문에, 그것들은 색수차를 최소화하는데 도움을 준다.

[을 제7호증 29면 14줄~30면 13줄]

이 사건 심결도 정정사항 1 내지 13은 이 사건 특허의 명세서 또는 도면에 기재된 사항의 범위 내에서 이루어진 것이라고 판단하였고, 이는 지극히 타당합니다.[17]

결국 피고 주장은 모두 이유 없고, 이 사건 정정발명에는 신규사항 추가의 무효사유가 없습니다.

17

갑 제1호증 심결문 13면
정정사항 1 내지 13은 특허청구범위를 감축한 경우에 해당하고, 이 사건 특허발명의 명세서 또는 도면에 기재된 사항의 범위에서 이루어진 것이며, 위 정정사항 1 내지 13으로 인하여 이 사건 특허발명의 목적이나 효과에 어떠한 변경도 없어 이 사건 특허발명이 실질적으로 확장하거나 변경하였다고 볼 수 없으므로 이 사건 정정청구는 특허법 제133조의2 제1항 및 제4항에서 준용하는 같은 법 제136조제1항, 제3항 및 제4항을 충족하는 적법한 정정으로 인정된다.

사. 이 사건 정정발명은 선행발명 1 단독에 의하여 또는 선행발명 1과 주지관용기술(을 제5, 6호증)의 결합에 의하여 진보성이 부정되지 않습니다.

피고는 이 사건 정정발명은 선행발명 1 단독에 의하여 또는 선행발명 1과 주지관용기술(을 제5, 6호증)의 결합에 의하여 진보성이 부정된다고 주장합니다(2021. 2. 8.자 피고 준비서면).

그러나 피고 주장은 모두 이유 없습니다.

(가) 선행발명 1은 실시불가능하고 통상의 기술자가 그 기술적 내용을 파악하기 어려우므로, 진보성 판단의 대비대상이 될 수 없습니다.

2021. 6. 3.자 원고 준비서면 3 내지 6면에서 설명드린 바와 같이 선행발명 1의 실시예 2의 제2 촬상광학계(LN2)는 제4 렌즈의 상측 면과 제5 렌즈의 물체측 면이 공간적으로 겹치도록 구성되어 있어 실제 구현이 불가능합니다. 이는 피고도 인정하고 있습니다.

또한 통상의 기술자가 위 구성을 실현 가능한 발명으로 파악하기도 어렵습니다.

따라서 선행발명 1은 진보성 판단에서 대비대상이 될 수 없습니다.

(나) 설령 선행발명 1이 대비대상이 될 수 있다고 하더라도 이 사건 정정발명은 선행발명 1에 의하여 진보성이 부정되지 않습니다.

이 사건 정정발명은 선행발명 1과 '제1 렌즈 요소의 초점 길이(f1)는 TTL/2보다 작은 구성', '제1 렌즈 요소는 볼록한 물체-측 표면과 볼록한 이미지-측 표면을 갖는 구성', 및 '렌즈 조립체의 F#는 2.9보다 작은 구성'의 차이가 있으며, 이는 양 당사자 간에 다툼이 없습니다.

피고는 선행발명 1의 단락 [0019]에 기재된 "1.0<fFw/fFm < 1.5 - 조건식 (1)"을 기초로 '제1 렌즈 요소의 초점 길이(f1)는 TTL/2보다 작은 구성'을 도출할 수 있고, '제1

렌즈 요소는 볼록한 물체-측 표면과 볼록한 이미지-측 표면을 갖는 구성'에 대하여는 아무런 기술적 의미를 가지지 않는다고 주장하며, '렌즈 조립체의 F#는 2.9보다 작은 구성'에 대하여는 아무런 기술적 실체를 가지지 못하는 무의미한 수치한정이라고 주장합니다.

그러나 2021. 6. 3.자 원고의 준비서면 6 내지 14면에서 설명드린 바와 같이 피고의 주장은 부당합니다.

1) '제1 렌즈 요소의 초점 길이(f1)는 TTL/2보다 작은 구성'에 대하여

피고가 주장하는 선행발명 1의 단락 [0019]에는 다음과 같은 기재가 있습니다.

2021. 2. 8.자 피고 준비서면 12면

[0019]
"1.0<fFw/fFm<1.5 … (1)
단,
fFw: 제1 촬상 광학계에 있어서의 제1 렌즈와 제2 렌즈의 합성 초점 거리,
fFm: 제2 촬상 광학계에 있어서의 제1 렌즈와 제2 렌즈의 합성 초점 거리
이다."
[0024]
"조건식 (1)의 하한을 상회하는 것은, 제2 촬상 광학계의 전군의 초점 거리가 제1 촬상 광학계의 전군의 초점 거리보다도 짧은(즉 파워가 강한) 것을 의미한다. 즉, 제2 촬상 광학계는 전체 계의 초점 거리가 상대적으로 길기 때문에, 전체적으로는 양의 파워가 약해지지만, 그에 반하여, 전체 계의 초점 거리가 짧은 제1 촬상 광학계의 전군보다도 파워를 강하게 하는 조건을 하한으로 규정하고 있다. 이 조건식 (1)을 만족시킴으로써, 제2 촬상 광학계의 텔레포토 경향을 강하게 할 수 있기 때문에, 장치로서의 전체 길이를 작게 하는 효과가 얻어진다."

[을 제4호증 [0019] 및 [0024] 단락의 번역문]

그런데 위 조건식 (1)은 제1 렌즈와 제2 렌즈의 합성 초점 거리에 관한 것이지, 제1 렌즈의 초점 거리에 관한 것이 아닙니다.

예를 들어 피고가 언급한 선행발명 1의 명세서(을 제4호증 단락 [0019] 및 [0024]), 위 명세서 중 노란색 표시 부분)도 제1렌즈(L1)와 제2렌즈(L2)의 합성 초점거리만을 개시하고 있으며, 제1렌즈(L1)의 초점거리를 분리하여 기재하고 있지 않습니다.

또한 위 선행발명 1의 위 단락은 f1을 TTL/2보다 작게 하는 구성을 기재하고 있지않습니다. 오히려 선행발명 1에 개시된 실시예는 모두 f1이 TTL/2보다 큰 값을

갖고 있습니다(아래 을 제4호증 단락 [0076] 노란색 부분 참조[18]).

을 제4호증 [0076] 표 1

		실시예1		실시예2	
		LN1	LN2	LN1	LN2
전체 계의 초점 거리 [mm]	fw 또는 fm	2. 73	4. 32	3. 70	5. 51
Fno	FNOw 또는 FNOm	4. 00	4. 00	3. 00	4. 00
렌즈 전체 길이(무한시)[mm]	TLw 또는 TLm	3. 04	3. 65	4. 45	4. 91
최대상 높이 [mm]	2Y'	5. 12	5. 12	5. 80	5. 80
전체 화각[deg]	2ωw 또는 2ωm	86. 32	61. 28	76. 18	55. 52
L1 초점 거리[mm]	f1w 또는 f1m	2. 60	2. 10	2. 47	2. 54

2) '제1 렌즈 요소는 볼록한 물체-측 표면과 볼록한 이미지-측 표면을 갖는 구성'에 대하여

피고는 제1 렌즈 요소의 이미지-측 표면이 오목한지 볼록한지 이 사건 정정발명과 관련하여 아무런 기술적 의미를 가지지 않으므로, 위 구성은 통상의 기술자가 적의 선택하여 용이하게 도출할 수 있다고 주장합니다.

그러나 렌즈의 형태에 따라 렌즈의 초점거리 등 구성요소가 상이해지며 이로 인해 렌즈 시스템의 효과가 상이해지는 것은 렌즈 시스템의 통상의 기술자에게 자명한 사실입니다. 따라서 렌즈 시스템의 설계에 있어서 렌즈의 형태는 기술적 의미를 갖는 것은 자명합니다.

선행발명 1의 망원 광학계들은 모두 제1 렌즈 요소의 이미지-측 표면이 오목한 특징적인 구성을 채택하고 있으며, 이와 달리 제1 렌즈 요소의 이미지-측 표면을 볼록한 형태로 변경할 만한 어떠한 동기도 제시되어 있지 않습니다.

3) '렌즈 조립체의 F#는 2.9보다 작은 구성'에 대하여

피고는 "F#가 2.9보다 작"은 구성에 대하여 아무런 기술적 실체를 가지지 못하는 무의미한 수치한정이라고 주장합니다.

[18] 을 제4호증 단락 [0076] 표1에 따르면, 실시예 1에서 f1은 2.1로 TTL/2인 1.825(=3.65/2)보다 크며, 실시예 2는 f1은 2.54로 TTL/2인 2.455(=4.91/2)보다 큽니다.

그러나 앞서 말씀드린 바와 같이, F#의 요건에서 최소한의 광량을 한정하는 구성은 고화질 구현을 위해 충분히 많은 광량이 요구됨을 고려하여 채택된 구성이고, 이는 종래 짧은 초점거리를 갖는 광각 광학계와는 달리 '소형 망원 렌즈 조립체' 에 관한 이 사건 정정발명의 특징적인 구성입니다.

선행발명 1도 청구항 7[19]에서 F#를 특징적인 구성요소로 기재하고 있습니다.

따라서 피고 주장은 이유 없습니다.

한편 선행발명 1에는 선행발명 1은 '<u>제1 촬상 광학계보다 제2 촬상 광학계 쪽을 어둡게 하는 편이 전체의 소형화를 달성하는 데 유리하다</u>'라고 기재하고 있고(을 제4호증 단락 [0038]), 각 실시예에서의 제1 촬상 광학계(광각)와 제2 촬상 광학계(망원)의 F#의 구체적인 값이 기재되어 있습니다(을 제4호증 단락 [0076]).

을 제4호증 단락 [0037] 및 [0038]

19

을 제4호증 30면
【청구항 7】 제1항 내지 제6항 중 어느 한 항에 있어서, 이하의 조건식 (5)를 만족시키는 것을 특징으로 하는 촬상 장치; 0.6<FNOw/FNOm<1.3 … (5) 단, FNOw: 제1 촬상 광학계의 F 넘버, FNOm: 제2 촬상 광학계의 F 넘버 이다.

【0037】

이하의 조건식 (5)를 만족시키는 것이 바람직하다.

0.6<FNOw/FNOm<1.3 … (5)

단,

FNOw: 제1 촬상 광학계의 F 넘버,

FNOm: 제2 촬상 광학계의 F 넘버

이다.

【0038】

전환 시에 F 넘버가 크게 상이하면, 흐려짐의 인상이 크게 바뀌게 되어, 사용자에게 있어서는 부자연스러워지므로, F 넘버는 조건식 (5)를 만족시키도록 제1, 제2 촬상 광학계에서 가까운 편이 바람직하다. 제1 촬상 광학계보다도 제2 촬상 광학계의 쪽을 어둡게 하는 편이 전체의 소형화를 달성하는 데 있어서 유리하게 된다.

을 제4호증 단락 [0076]

		실시예1		실시예2	
		LN1	LN2	LN1	LN2
전체 계의 초점 거리 [mm]	fw 또는 fm	2. 73	4. 32	3. 70	5. 51
Fno	FNOw 또는 FNOm	4. 00	4. 00	3. 00	4. 00
렌즈 전체 길이(무한시)[mm]	TLw 또는 TLm	3. 04	3. 65	4. 45	4. 91
최대상 높이 [mm]	2Y'	5. 12	5. 12	5. 80	5. 80
전체 화각[deg]	2ωw 또는 2ωm	86. 32	61. 28	76. 18	55. 52

선행발명 1의 단락 [0037]에 기재된 "0.6<FNOw/FNOm<1.3 … (5)"은 광각 광학계와 망원 광학계 사이의 F# 비율에 관한 것으로서, 전환 시에 흐려짐의 인상이 크게 바뀌어 부자연스러운 것을 방지하기 위하여 두 광학계의 F#을 일정 범위 내에 있도록 한 것입니다.

이때 선행발명 1이 제시하는 2개의 실시예에서 광각 광학계(LN1)의 F#는 3.00 또는 4.00으로 다른 값을 갖는데 반하여, 망원 광학계(LN2)의 F#는 4.00으로 동일합니다. 즉 선행발명 1은 두 광학계 사이의 F# 비율에 있어서 광각 광학계의 F#를 변경할 동기는 가지고 있을지언정 망원 광학계의 F#를 변경(예컨대, 4.00보다 작게)

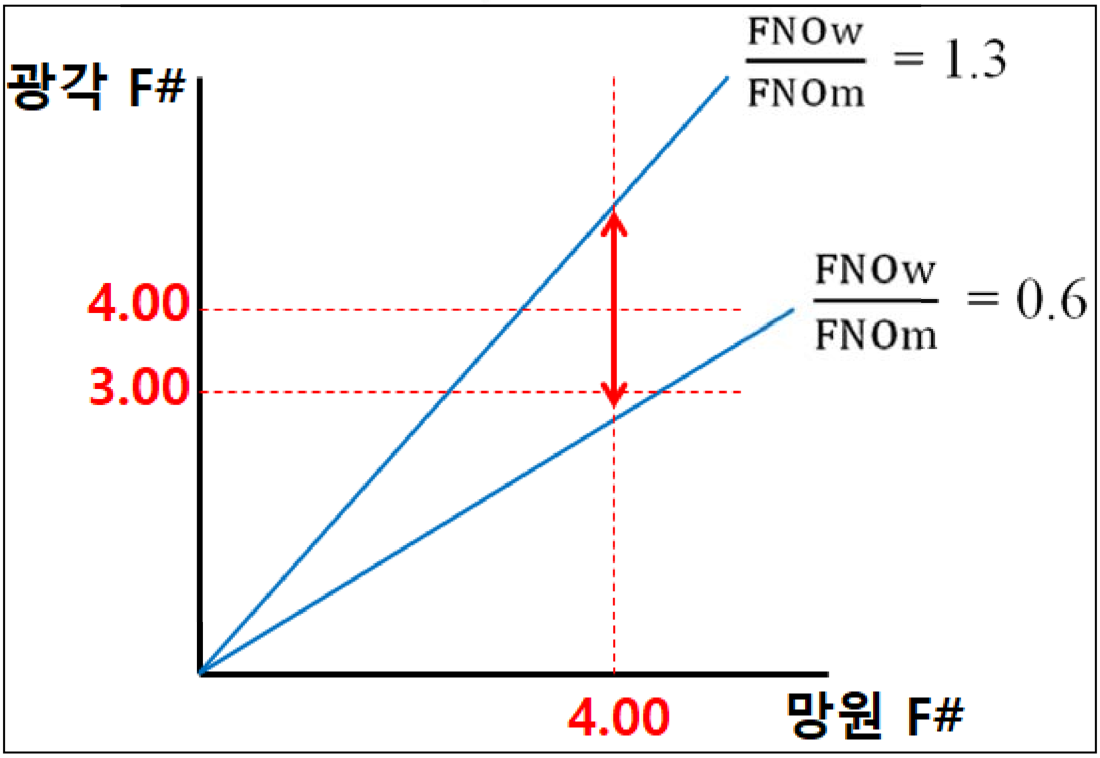
하려는 동기를 제시하지는 못하고 있는 것입니다.

선행발명 1은 망원 광학계의 F#를 변경하려는 노력보다는 망원 광학계의 F#는 4.00으로 설계하고, 흐려짐의 인상을 고려하여 광각 광학계의 F#를 3.00 또는 4.00으로 한 것에 불과합니다(을 제4호증 단락 [0038] 참조).

전환 시에 F 넘버가 크게 상이하면, 흐려짐의 인상이 크게 바뀌게 되어, 사용자에게 있어서는 부자연스러워지므로, F 넘버는 조건식 (5)를 만족시키도록 제1, 제2 촬상 광학계에서 가까운 편이 바람직하다. 제1 촬상 광학계보다도 제2

[을 제4호증 단락[0038]]

이와 같이 선행발명 1은 망원 광학계의 F#를 낮추려는 동기를 제공하는 것이 아니라, 망원 광학계의 F#인 4.00을 기초로 광각 광학계의 F#를 조절하여 광각 광학계와 망원 광학계의 비율을 0.6~1.3의 범위로 조정하는 것입니다.



반면 이 사건 특허발명에서 F#을 2.9 미만으로 함으로써 얻어지는 효과는 선행발명 1에서는 예상하기 어려운 이질적 효과에 해당합니다. 선행발명 1에서는 이러한 효과를 얻기 위하여 망원 광학계의 F#을 변경할 동기를 찾아보기 어렵습니다.

결국 통상의 기술자는 선행발명 1로부터 '렌즈 조립체의 F#는 2.9보다 작은 구성'을 도출할 수 없습니다.

(다) 이 사건 정정발명은 선행발명 1과 을 제5, 6호증의 선행기술의 결합에 의하여 진보성이 부정되지 않습니다.

2021. 2. 8.자 피고의 준비서면 3 내지 18면에서 피고는 위 차이점 1 내지 3에 해당하는 구성을 각각 분해한 후, 분해된 개별 구성요소들이 을 제5, 6호증의 선행기술에 개시되어 있다거나, 그러한 개별 구성요소들이 주지관용기술에 해당한다고 주장합니다.

그러나 2021. 6. 3.자 원고의 준비서면 14 내지 32면에서 설명드린 바와 같이 피고 주장은 이 사건 정정발명에 기재된 구성간 유기적 결합관계를 전혀 고려하지 않은 것으로, 피고의 주장과는 달리 일반 카메라용 렌즈 시스템과 휴대 단말기용 소형 망원 렌즈 조립체는 렌즈 시스템 자체가 상이하여 서로 결합할 수 없고, 피고가 주장하는 구성은 주지관용기술에 해당하지도 않습니다.

	피고의 주장			피고 주장의 부당성
	f1<TTL/2	제1 렌즈요소의 양-측 표면 볼록	F#<2.9	
선행발명1	X	X	X	구성요소를 개시하고 있지 않음
을제5호증의2	o	o	-	F#가 2.9를 현저히 초과함 TTL ≤ 6.5 mm 이 아닌 일반 대형 카메라 망원 렌즈로 이 사건 특허와 결합할 수 없음
을제5호증의3	o	o	-	F#가 2.9를 현저히 초과함

				TTL ≤ 6.5 mm 이 아닌 일반 대형 카메라 망원 렌즈로 이 사건 특허와 결합할 수 없음
을제5호증의4	o	o	-	F#가 2.9를 현저히 초과함 TTL ≤ 6.5 mm 이 아닌 일반 대형 카메라 망원 렌즈로 이 사건 특허와 결합할 수 없음
을제6호증의1	-	-	o	TTL/EFL < 1 이 아닌 광각 렌즈로 이 사건 특허와 결합할 수 없음
을제6호증의2	-	-	o	f1 < TTL/2 이 아님 일반 대형 카메라 망원 렌즈로 이 사건 특허와 결합할 수 없음
을제6호증의3	-	-	o	f1 < TTL/2 이 아님 일반 대형 카메라 망원 렌즈로 이 사건 특허와 결합할 수 없음
을제6호증의4	-	-	o	TTL/EFL < 1 이 아닌 광각 렌즈로 이 사건 특허와 결합할 수 없음
을제6호증의5	-	-	o	TTL/EFL < 1 이 아닌 광각 렌즈로 이 사건 특허와 결합할 수 없음

먼저 피고의 주장은 청구항에 기재된 복수의 구성을 분해한 후 각각 분해된 개별 구성요소들이 공지된 것인지 여부만을 따지는 것으로서 진보성 판단에 관한 대법원 판례에 정면으로 반합니다.[20]

20

대법원 2007. 11. 29. 선고 2006후2097 판결
어느 특허발명의 특허청구범위에 기재된 청구항이 복수의 구성요소로 되어 있는 경우에는 각 구성요소가 유기적으로 결합한 전체로서의 기술사상이 진보성 판단의 대상이 되는 것이지 각 구성요소가 독립하여 진보성 판단의 대상이 되는 것은 아니므로, 그 특허발명의 진보성 여부를 판단함에 있어서는 청구항에 기재된 복수의 구성을 분해한 후 각각 분해된 개별 구성요소들이 공지된 것인지 여부만을 따져서는 안 되고, 특유의 과제 해결원리에 기초하여 유기적으로 결합된 전체로서의 구성

또한 피고가 제출한 을 제6호증의1도 일반 대형 카메라용 렌즈 시스템의 설계와 휴대 단말기용 소형 렌즈 조립체의 설계는 분명하게 다르다고 언급하고 있고,[21] 일반 카메라의 렌즈 형태는 휴대 단말기용으로는 적합하지 않으므로 휴대 단말기용 렌즈 조립체는 일반 카메라의 렌즈 시스템에 기초한 것이 아니라 새롭게 설계를 해야 합니다.

나아가 몇 개의 선행문헌에 개시되었다는 사정만으로 주지관용기술이라고 인정될 수 없고, 유기적으로 결합된 전체 렌즈 조립체에서 일부 구성만을 발췌하여 해당 구성이 주지관용기술이라고 볼 수도 없습니다.[22]

결국 피고 주장은 모두 이유 없고, 이 사건 정정발명은 선행발명 1 단독에 의하여 또는 선행발명 1과 주지관용기술(을 제5 내지 6호증)과의 결합에 의하여 진보성이 부정될 수 없습니다.

아. 이 사건 정정발명은 출원일이 우선일로 소급되므로, 선행발명 2는 확대된 선출원의 선행발명이 될 수 없습니다.

피고는 2021. 2. 8.자 피고의 준비서면 19 내지 22면에서 이 사건 정정발명의 명세서는 우선권출원 명세서와 발명의 기술내용이 동일하지 않게 기재되어 있으므로, 그 출원일이 우선일로 소급될 수 없다고 주장합니다.

그러나 통상의 기술자는 출원 시의 기술상식에 비추어 보아 이 사건 특허발명의 TTL 및 F# 수치범위, "음의 광학력을 함께 갖는 한 쌍의 제2 및 제3 렌즈 요소들"이라는 구성은 모두 우선권출원 명세서 등에 기재되어 있는 것이라고 이해할 수 있습니다.

의 곤란성을 따져 보아야 할 것이며, 이 때 결합된 전체 구성으로서의 발명이 갖는 특유한 효과도 함께 고려하여야 한다(대법원 2007. 9. 6. 선고 2005후3277 판결 참조).

[21] 2021. 6. 3. 자 원고의 준비서면 17 내지 22면 참조
[22] 2021. 6. 3. 자 원고의 준비서면 23 내지 33면 참조

결국 이 사건 정정발명의 출원일이 우선일인 2013. 7. 4.로 소급되므로, 우선일이 2013. 10. 31.인 선행발명 2는 확대된 선출원의 선행발명이 될 수 없습니다.

4. 결 론

이상과 같이 피고 주장은 모두 이유 없고, 이 사건 정정발명에는 아무런 무효사유가 없습니다. 따라서 이 사건 심결을 취소하여 주시기 바랍니다.

참 고 자 료

1. 참고자료 1 과학백과사전 레스폰스함수 검색화면
1. 참고자료 2 OPPO X907 사양
1. 참고자료 3 후지쯔 Arrows ES IS12F 사양
1. 참고자료 4 화웨이 Ascend P1s 사양
1. 참고자료 5 애플 iPhone5 사양
1. 참고자료 6 삼성전자 갤럭시S4 매뉴얼
1. 참고자료 7 SONY 엑스페리아 Z 울트라 사양
1. 참고자료 8 삼성홈페이지 폴디드 렌즈 화면

첨 부 서 류

1. 위 참고자료 각 1통

2021. 8. 2.

원고 소송대리인

법무법인(유) 율 촌

담당변호사 최 정 열

담당변호사 정 상 태

담당변호사 이 한 결

담당변호사 김 하 영

특허법인 씨엔에스

담당변리사 손 원

담당변리사 황 우 택

담당변리사 이 의 훈

담당변리사 윤 병 훈

담당변리사 안 성 수

담당변리사 곽 인 영

특허법원 제 3 부 귀중

Google Translate ×

translate.google.com/?sl=ko&tl=en&text=이%20사건%20특허발명%...

Apps HB Links Inbox · Outlook - Welcome! | LinkedIn » Other bookmarks Reading list

Google Translate

Text Documents

DETECT LANGUAGE KOREAN ENGLISH SPANISH ENGLISH SPANISH ARABIC

이 사건 특허발명 출원 당시(2013년경)에는 휴대 단말기에 망원 렌즈 조립체를 장착 하는 기술은 거의 없었고, 이 사건 특허발명의 발명자들은 소형의 휴대 단말기에 장 착하여 양질의 이미지를 얻을 수 있는 소형 망원 렌즈 조립체를 연구한 결과 최적의 TTL의 상한 및 F#의 상한을 도출한 것입니다.

i sageon teugheobalmyeong chul-won dangsi(2013nyeongyeong)eneun hyudae danmalgie mang-won lenjeu jolibcheleul jangchag haneun gisul-eun geoui eobs-eossgo, i sageon teugheobalmyeong-ui balmyeongjadeul-eun sohyeong-ui hyudae danmalgie jang chaghayeo yangjil-ui imijileul eod-eul su issneun sohyeong mang-won lenjeu jolibcheleul yeonguhan gyeolgwa choejeog-ui TTLui sanghan mich F#ui sanghan-eul dochulhan geos-ibnida.

Show less

167 / 5000

At the time of filing for the patent in this case (around 2013), there was almost no technology for mounting a telephoto lens assembly in a portable terminal, and the inventors of this case patented a small telephoto lens that can obtain high-quality images by attaching it to a small portable terminal. Studying the assembly resulted in an optimal upper limit of TTL and an upper limit of F#.

Send feedback

Google Translate

translate.google.com/?sl=ko&tl=en&text=이%20사건%20특허의%20...

Apps | HB Links | Inbox - | Outlook - | Welcome! | LinkedIn | » | Other bookmarks | Reading list

Google Translate

Text | Documents

DETECT LANGUAGE | KOREAN | ENGLISH | SPANISH ⇄ ENGLISH | SPANISH | ARABIC

이 사건 특허의 명세서 단락 [0004], [0005]는 종래기술로 4개의 렌즈 요소들을 포함 하는 렌즈 조립체는 소형의 이미지 촬영 렌즈 시스템으로서 양호한 품질의 이미지를 얻기에 충분하지 않았고 5개의 렌즈 요소들을 사용한 (광각 렌즈 조립체인) US 제 8,395,851호는 TTL 및 EFL 사이의 비율이 큰 문제점이 있다고 기재하고 있습니다. 이는 이 사건 특허발명 출원 당시 휴대 단말기에 적용되는 망원 렌즈 조립체가 거의 없었기 때문입니다.

i sageon teugheoui myeongseseo danlag [0004], [0005]neun jonglaegisullo 4gaeui lenjeu yosodeul-eul poham haneun lenjeu jolibcheneun sohyeong-ui imiji chwal-yeong lenjeu siseutem-euloseo yanghohan pumjil-ui imijileul eodgie chungbunhaji anh-assgo 5gaeui lenjeu yosodeul-eul sayonghan (gwang-gag lenjeu jolibchein) US je 8,395,851honeun TTL mich EFL saiui biyul-i keun munjejeom-i issdago gijaehago issseubnida. ineun i sageon teugheobalmyeong chul-won dangsi hyudae danmalgie jeog-yongdoeneun mang-won lenjeu jolibchega geoui eobs-eossgi ttaemun-ibnida.

Show less

253 / 5000

The specification paragraphs [0004] and [0005] of this case patent stated that, as a prior art, a lens assembly including four lens elements was not sufficient to obtain a good quality image as a compact imaging lens system, and five lens elements were used. US 8,395,851 (which is a wide-angle lens assembly) states that there is a problem with the large ratio between TTL and EFL. This is because there were hardly any telephoto lens assemblies applied to mobile terminals at the time the patent invention was filed in this case.

Send feedback

Google Translate

translate.google.com/?sl=ko&tl=en&text=이%20사건%20특허발명%20출...

Apps HB Links Inbox - Outlook - Welcome! | LinkedIn » Other bookmarks Reading list

Google Translate

Text Documents

DETECT LANGUAGE KOREAN ENGLISH SPANI

ENGLISH SPANISH ARABIC

이 사건 특허발명 출원 당시(2013년경) 휴대 단말기에 망원 렌즈 조립체를 장착하는 선행문헌은 1건에 불과하였고, 휴대 단말기용 카메라 제조업체 대부분은 '망원 렌즈 조립체'가 아닌 '광각 렌즈 조립체'를 개발 하려고 노력하고 있었습니다.

i sageon teugheobalmyeong chul-won dangsi(2013nyeongyeong) hyudae danmalgie mang-won lenjeu jolibcheleul jangchaghaneun seonhaengmunheon-eun 1geon-e bulgwahayeossgo, hyudae danmalgiyong kamela jejo-eobche daebubun-eun 'mang-won lenjeu jolibche'ga anin 'gwang-gag lenjeu jolibche'leul gaebal halyeogo nolyeoghago iss-eossseubnida.

Show less

134 / 5000

At the time of filing for the patent invention in this case (around 2013), there was only one precedent document that installed a telephoto lens assembly in a mobile terminal, and most of the camera manufacturers for mobile terminals tried to develop a 'wide-angle lens assembly' rather than a 'telephoto lens assembly'. I was trying.

Send feedback

O'Brien, David

From: Neil Rubin <nrubin@raklaw.com>
Sent: Monday, August 16, 2021 3:04 AM
To: Trials
Cc: Marc Fenster; James Tsuei; Jonathan Link; O'Brien, David; Shi, Hong; Parsons, Michael; Ehmke, Andrew S.
Subject: Re: IPR2020-00489 // Petitioner's request to admit evidence with rehearing request

EXTERNAL: Sent from outside Haynes and Boone, LLP

Dear Honorable Board,

Counsel for Corephotonics is available after 1:00 pm Eastern on Tuesday, August 17 or after noon Eastern on Wednesday, August 18.

However, Corephotonics requests that no conference call be scheduled until Apple has made available to Corephotonics and the Board the certified translation that it seeks to have admitted into the record. The Korean document in question is a 30-page post-hearing brief, which is responding to arguments made by defendant LG and questions raised by the court in the Korean proceeding. It is addressing a patent specification, claim limitations, prior art, and a factual record that are all different than those at issue in IPR2020-00489. We do not believe that the Board can fairly judge whether this new document should be admitted based on machine translations of isolated paragraphs taken out of context.

Neil A. Rubin

RUSS AUGUST & KABAT | 12424 Wilshire Boulevard, 12th Floor | Los Angeles, CA 90025
Main +1 310 826 7474 | Direct +1 310 979 8252 | nrubin@raklaw.com | www.raklaw.com

On Aug 13, 2021, at 8:27 PM, O'Brien, David <David.OBrien@haynesboone.com> wrote:

Judges Moore, Anderson and Ullagaddi,
Petitioner writes following yesterday's oral hearing in IPR2020-00906 (before Judges Moore, Ullagaddi and Horvath) after which options for addressing a pending admission-of-new-evidence question relative to the IPR2020-00906 proceeding were discussed with the Board and amongst parties. Per the panel's suggestion, Parties have since conferred, and Patent Owner has agreed to withdraw its opposition to authorization for Apple's motion to admit new evidence into the IPR2020-00906 proceeding. The IPR2020-00489 proceeding presents an analogous question but has a different timeline, and the Trial Practice Guide (TPG) provides a conference call process for the panel to decide the evidence question prior to rehearing. See Consolidated TPG, 90 (November 2019) ("Ideally, a party seeking to admit new evidence with a rehearing request would request a conference call ….").
Apple respectfully requests the TPG-provided conference call with the Board regarding admission into the record of Patent Owner's admissions that contradict a critical position that it has taken in this proceeding and upon which the Board relied in its final written decision. Specifically, Apple seeks admission of a brief that Patent Owner Corephotonics filed on August 2, 2021 in the Korean IPTAB proceeding titled Case No. 2020 Heo 6323 (see attached pdf, hereinafter "Korean Brief"). The Korean Brief goes not simply to the weight and credibility of expert testimony, but is a party admission, which should carry at least persuasive—if not prosecution history and judicial—estoppel effect. Apple is

obtaining a certified translation as required by 37 CFR § 42.63(b). Apple's counsel is, for purposes of this request and the conference call, relying on a machine translation until a certified translation is available. Good cause exists for including the Korean Brief in the record because (1) the Brief was filed eleven days ago, just after the Board rendered its final written decision and (2) Patent Owner's admission concerns a fundamental issue underpinning its arguments in this proceeding—and specifically contradicts its position on that issue taken here. Here, Patent Owner argued against combining Golan and Kawamura, alleging that a POSITA would have looked to numerous "well-known" miniature telephoto designs in 2013 for use in Golan's system. For example, Patent Owner argues:

- "There was also no shortage of miniature lens designs for a POSITA to use or to improve on …" POR, at 46.
- "Dr. Moore's declaration explains that it was significant, significant enough that a POSITA would have recognized that the result of scaling Kawamura was inferior in terms of materials, design, manufacturability, and performance to more current <u>'well-known' miniature telephoto lens designs</u>." Sur-Reply at 14 (relying on Dr. Moore's declaration at Ex. 2003, ¶87) (underline added).
- "[T]elephoto lenses specifically for mobile phones were <u>well-known by 2013</u>, not that we're limited to mobile phones, but the point is that if telephoto lenses <u>were available now in miniature lenses in 2013</u>, why would you need to go back to Kawamura for a telephoto lens." Hearing Transcript, 29:21-24 (underline added).

In the Korean proceedings, Patent Owner admitted the opposite to the Korean Patent Office and Supreme Court: that there were almost no telephoto lens assemblies for small form factors available in 2013.

- "At the time of filing for the [Subject Patent] (around 2013) <u>there was only one precedent document that installed a telephoto lens assembly in a mobile terminal</u>, and most of the camera manufacturers for mobile terminals tried to develop a 'wide-angle lens assembly' rather than a 'telephoto lens assembly'. Google Translate of Korea Brief (see attached), at 2 (underline added).
- "… <u>there were hardly any telephoto lens assemblies applied to mobile terminals</u> at the time the patent invention was filed in this case." *Id.* at 2 (underline added).
- "At the time of filing for the patent in this case (around 2013), <u>there was almost no technology for mounting a telephoto lens assembly in a portable terminal</u> . . ." *Id.* at 6 (underline added).

Patent Owner's arguments in the Korean Brief contradict Patent Owner's arguments here that there were "well-known" miniature telephoto lens designs" or "no shortage" of miniature lens designs that would have been suitable by 2013 for the tele lens in Golan's camera. Petitioner therefore seeks to admit the Korean Brief and a certified translation into the record to show contradictory statements from Patent Owner about the availability of miniature telephoto lens designs in 2013.

Apple's counsel is available for the conference call with the Board on between 10am and 4pm, Tuesday or Wednesday, 17-18 August or otherwise at the panel's convenience. Patent Owner continues to oppose admission of the Korean Brief and translation into the IPR2020-00489 record but has not indicated its availability for the conference call.

During the discussion amongst Board and parties after yesterday's IPR2020-00906 hearing, the panel expressed concerns regarding timeline for certified translation, written briefing, and rehearing in this IPR2020-00489 proceeding. Apple is not opposed to written briefing of the good-cause-for-admission-of-new-evidence question in IPR2020-00489, provided that the panel can quickly turn a written Order and sufficiently extend the deadline for requesting rehearing without overrunning the 63-day deadline for appeal to the Federal Circuit.

David O'Brien
Partner
david.obrien@haynesboone.com

Haynes and Boone, LLP
600 Congress Avenue
Suite 1300
Austin, TX 78701-3285

(t) +1 512.867.8457
(f) +1 512.867.8613

vCard | Bio | Website

O'Brien, David

From: O'Brien, David
Sent: Tuesday, August 17, 2021 3:36 PM
To: Trials; Neil Rubin
Cc: Marc Fenster; James Tsuei; Jonathan Link; Shi, Hong; Parsons, Michael; Ehmke, Andrew S.
Subject: RE: IPR2020-00489 // Petitioner's request to admit evidence with rehearing request

(Given the 25-August-2021 deadline for rehearing, the need for a decision by the panel is becoming increasingly urgent.)

Dear Honorable Board,

In view of Patent Owner's suggestion (in eMail response below) that the admissibility question ***in this proceeding IPR2020-00489*** cannot even be fairly judged until a *certified* translation has been made available to the parties and Board, Petitioner respectfully requests that the Board extend the 30-day period of time set by § 42.71(d)(2) for the filing of a request for rehearing. The Board has authority to extend at least under 37 C.F.R. §§ 42.5(c)(1,2) as well as under §§ 42.5(a,b). **Good cause** for such an extension exists for the same reasons articulated with respect to the principal question of admission of new evidence, and further in view of the facts that (i) the Korean language evidence came into existence just 15 days ago based on Patent Owner's own post-final written decision briefing and has promptly been brought to the attention of the panel and (ii) Petitioner is diligently working to secure the certified translation required by § 42.63(b).

Petitioner remains available for a telephone conference with the Board on Wednesday or otherwise at the panel's convenience. During the conference, a specific length of extension can be tailored to allow sufficient time for the Board's decision on admission of the Korean Brief.

HAYNES BOONE

David O'Brien | Partner
david.obrien@haynesboone.com | (t) +1 512.867.8457

From: Neil Rubin
Sent: Monday, August 16, 2021 3:04 AM
To: Trials
Cc: Marc Fenster ; James Tsuei ; Jonathan Link ; O'Brien, David ; Shi, Hong ; Parsons, Michael ; Ehmke, Andrew S.
Subject: Re: IPR2020-00489 // Petitioner's request to admit evidence with rehearing request

Dear Honorable Board,

Counsel for Corephotonics is available after 1:00 pm Eastern on Tuesday, August 17 or after noon Eastern on Wednesday, August 18.

However, Corephotonics requests that no conference call be scheduled until Apple has made available to Corephotonics and the Board the certified translation that it seeks to have admitted into the record. The Korean document in question is a 30-page post-hearing brief, which is responding to arguments made by defendant LG and questions raised by the court in the Korean proceeding. It is addressing a patent specification, claim limitations, prior art, and a factual record that are all different than those at issue in IPR2020-00489. We do not believe that the Board can fairly judge whether this new document should be admitted based on machine translations of isolated paragraphs taken out of context.

Neil A. Rubin

RUSS AUGUST & KABAT | 12424 Wilshire Boulevard, 12th Floor | Los Angeles, CA 90025
Main +1 310 826 7474 | Direct +1 310 979 8252 | nrubin@raklaw.com | www.raklaw.com

On Aug 13, 2021, at 8:27 PM, O'Brien, David <David.OBrien@haynesboone.com> wrote:

Judges Moore, Anderson and Ullagaddi,

Petitioner writes following yesterday's oral hearing in IPR2020-00906 (before Judges Moore, Ullagaddi and Horvath) after which options for addressing a pending admission-of-new-evidence question relative to the IPR2020-00906 proceeding were discussed with the Board and amongst parties. Per the panel's suggestion, Parties have since conferred, and Patent Owner has agreed to withdraw its opposition to authorization for Apple's motion to admit new evidence into the IPR2020-00906 proceeding. The IPR2020-00489 proceeding presents an analogous question but has a different timeline, and the Trial Practice Guide (TPG) provides a conference call process for the panel to decide the evidence question prior to rehearing. See Consolidated TPG, 90 (November 2019) ("Ideally, a party seeking to admit new evidence with a rehearing request would request a conference call ….").

Apple respectfully requests the TPG-provided conference call with the Board regarding admission into the record of Patent Owner's admissions that contradict a critical position that it has taken in this proceeding and upon which the Board relied in its final written decision. Specifically, Apple seeks admission of a brief that Patent Owner Corephotonics filed on August 2, 2021 in the Korean IPTAB proceeding titled Case No. 2020 Heo 6323 (see attached pdf, hereinafter "Korean Brief"). The Korean Brief goes not simply to the weight and credibility of expert testimony, but is a party admission, which should carry at least persuasive—if not prosecution history and judicial—estoppel effect. Apple is obtaining a certified translation as required by 37 CFR § 42.63(b). Apple's counsel is, for purposes of this request and the conference call, relying on a machine translation until a certified translation is available.

Good cause exists for including the Korean Brief in the record because (1) the Brief was filed eleven days ago, just after the Board rendered its final written decision and (2) Patent Owner's admission concerns a fundamental issue underpinning its arguments in this proceeding—and specifically contradicts its position on that issue taken here. Here, Patent Owner argued against combining Golan and Kawamura, alleging that a POSITA would have looked to numerous "well-known" miniature telephoto designs in 2013 for use in Golan's system. For example, Patent Owner argues:

- "There was also no shortage of miniature lens designs for a POSITA to use or to improve on …" POR, at 46.
- "Dr. Moore's declaration explains that it was significant, significant enough that a POSITA would have recognized that the result of scaling Kawamura was inferior in terms of materials, design, manufacturability, and performance to more current 'well-known' miniature telephoto lens designs." Sur-Reply at 14 (relying on Dr. Moore's declaration at Ex. 2003, ¶87) (underline added).
- "[T]elephoto lenses specifically for mobile phones were well-known by 2013, not that we're limited to mobile phones, but the point is that if telephoto lenses were available now in miniature lenses in 2013, why would you need to go back to Kawamura for a telephoto lens." Hearing Transcript, 29:21-24 (underline added).

In the Korean proceedings, Patent Owner admitted the opposite to the Korean Patent Office and Supreme Court: that there were almost no telephoto lens assemblies for small form factors available in 2013.

- "At the time of filing for the [Subject Patent] (around 2013) there was only one precedent document that installed a telephoto lens assembly in a mobile terminal, and most of the camera manufacturers for mobile terminals tried to develop a 'wide-angle lens assembly' rather than a 'telephoto lens assembly'. Google Translate of Korea Brief (see attached), at 2 (underline added).
- "… there were hardly any telephoto lens assemblies applied to mobile terminals at the time the patent invention was filed in this case." *Id.* at 2 (underline added).
- "At the time of filing for the patent in this case (around 2013), there was almost no technology for mounting a telephoto lens assembly in a portable terminal . . ." *Id.* at 6 (underline added).

Patent Owner's arguments in the Korean Brief contradict Patent Owner's arguments here that there were "well-known" miniature telephoto lens designs" or "no shortage" of miniature lens designs that would have been suitable by 2013 for the tele lens in Golan's camera. Petitioner therefore seeks to admit the Korean Brief and a certified translation into the record to show contradictory statements from Patent Owner about the availability of miniature telephoto lens designs in 2013.

Apple's counsel is available for the conference call with the Board on between 10am and 4pm, Tuesday or Wednesday, 17-18 August or otherwise at the panel's convenience. Patent Owner continues to oppose admission of the Korean Brief and translation into the IPR2020-00489 record but has not indicated its availability for the conference call.

During the discussion amongst Board and parties after yesterday's IPR2020-00906 hearing, the panel expressed concerns regarding timeline for certified translation, written briefing, and rehearing in this IPR2020-00489 proceeding. Apple is not opposed to written briefing of the good-cause-for-admission-of-new-evidence question in IPR2020-00489, provided that the panel can quickly turn a written Order and sufficiently extend the deadline for requesting rehearing without overrunning the 63-day deadline for appeal to the Federal Circuit.

David O'Brien
Partner
david.obrien@haynesboone.com

Haynes and Boone, LLP
600 Congress Avenue
Suite 1300
Austin, TX 78701-3285

(t) +1 512.867.8457
(f) +1 512.867.8613

vCard | Bio | Website

상대방 참고서면.pdf>

O'Brien, David

From: Trials <Trials@USPTO.GOV>
Sent: Wednesday, August 18, 2021 8:01 AM
To: Neil Rubin; Trials
Cc: Marc Fenster; James Tsuei; Jonathan Link; O'Brien, David; Shi, Hong; Parsons, Michael; Ehmke, Andrew S.
Subject: RE: IPR2020-00489 // Petitioner's request to admit evidence with rehearing request

EXTERNAL: Sent from outside Haynes and Boone, LLP

Counsel,

Petitioner's counsel is advised that substantive arguments are not permitted in email communications to the Board. The arguments presented in Petitioner's emails of August 13 and 17 will not be considered. As to Petitioner's request to brief the question of whether good cause exists to admit into evidence the Korean language document at issue, given the stage of the proceedings, we decline to decide the admissibility of the Korean language document based on an incomplete, uncertified document (i.e., the Google translate files attached to Petitioner's email of August 13, 2021), the entire context of which is unclear. Petitioner may revisit this request at such time as a complete certified translation is available.

Regards,

Andrew Kellogg,
Supervisory Paralegal
Patent Trial and Appeal Board
USPTO
andrew.kellogg@uspto.gov
(571)272-7822

From: Neil Rubin
Sent: Monday, August 16, 2021 4:04 AM
To: Trials
Cc: Marc Fenster ; James Tsuei ; Jonathan Link ; O'Brien, David ; Shi, Hong ; Parsons, Michael ; Ehmke, Andrew S.
Subject: Re: IPR2020-00489 // Petitioner's request to admit evidence with rehearing request

CAUTION: This email has originated from a source outside of USPTO. **PLEASE CONSIDER THE SOURCE** before responding, clicking on links, or opening attachments.

Dear Honorable Board,

Counsel for Corephotonics is available after 1:00 pm Eastern on Tuesday, August 17 or after noon Eastern on Wednesday, August 18.

However, Corephotonics requests that no conference call be scheduled until Apple has made available to Corephotonics and the Board the certified translation that it seeks to have admitted into the record. The Korean document in question is a 30-page post-hearing brief, which is responding to arguments made by defendant LG and questions raised by the court in the Korean proceeding. It is addressing a patent specification, claim limitations, prior art, and a factual record that are all different than those at issue in IPR2020-00489. We do not believe that the Board can fairly judge whether this new document should be admitted based on machine translations of isolated paragraphs taken out of context.

Neil A. Rubin

RUSS AUGUST & KABAT | 12424 Wilshire Boulevard, 12th Floor | Los Angeles, CA 90025
Main +1 310 826 7474 | Direct +1 310 979 8252 | nrubin@raklaw.com | www.raklaw.com

On Aug 13, 2021, at 8:27 PM, O'Brien, David <David.OBrien@haynesboone.com> wrote:

Judges Moore, Anderson and Ullagaddi,

Petitioner writes following yesterday's oral hearing in IPR2020-00906 (before Judges Moore, Ullagaddi and Horvath) after which options for addressing a pending admission-of-new-evidence question relative to the IPR2020-00906 proceeding were discussed with the Board and amongst parties. Per the panel's suggestion, Parties have since conferred, and Patent Owner has agreed to withdraw its opposition to authorization for Apple's motion to admit new evidence into the IPR2020-00906 proceeding. The IPR2020-00489 proceeding presents an analogous question but has a different timeline, and the Trial Practice Guide (TPG) provides a conference call process for the panel to decide the evidence question prior to rehearing. See Consolidated TPG, 90 (November 2019) ("Ideally, a party seeking to admit new evidence with a rehearing request would request a conference call ....").

Apple respectfully requests the TPG-provided conference call with the Board regarding admission into the record of Patent Owner's admissions that contradict a critical position that it has taken in this proceeding and upon which the Board relied in its final written decision. Specifically, Apple seeks admission of a brief that Patent Owner Corephotonics filed on August 2, 2021 in the Korean IPTAB proceeding titled Case No. 2020 Heo 6323 (see attached pdf, hereinafter "Korean Brief"). The Korean Brief goes not simply to the weight and credibility of expert testimony, but is a party admission, which should carry at least persuasive—if not prosecution history and judicial—estoppel effect. Apple is obtaining a certified translation as required by 37 CFR § 42.63(b). Apple's counsel is, for purposes of this request and the conference call, relying on a machine translation until a certified translation is available.

Good cause exists for including the Korean Brief in the record because (1) the Brief was filed eleven days ago, just after the Board rendered its final written decision and (2) Patent Owner's admission concerns a fundamental issue underpinning its arguments in this proceeding—and specifically contradicts its position on that issue taken here. Here, Patent Owner argued against combining Golan and Kawamura, alleging that a POSITA would have looked to numerous "well-known" miniature telephoto designs in 2013 for use in Golan's system. For example, Patent Owner argues:

- "There was also no shortage of miniature lens designs for a POSITA to use or to improve on …" POR, at 46.

- "Dr. Moore's declaration explains that it was significant, significant enough that a POSITA would have recognized that the result of scaling Kawamura was inferior in terms of materials, design, manufacturability, and performance to more current 'well-known' miniature telephoto lens designs." Sur-Reply at 14 (relying on Dr. Moore's declaration at Ex. 2003, ¶87) (underline added).
- "[T]elephoto lenses specifically for mobile phones were well-known by 2013, not that we're limited to mobile phones, but the point is that if telephoto lenses were available now in miniature lenses in 2013, why would you need to go back to Kawamura for a telephoto lens." Hearing Transcript, 29:21-24 (underline added).

In the Korean proceedings, Patent Owner admitted the opposite to the Korean Patent Office and Supreme Court: that there were almost no telephoto lens assemblies for small form factors available in 2013.

- "At the time of filing for the [Subject Patent] (around 2013) there was only one precedent document that installed a telephoto lens assembly in a mobile terminal, and most of the camera manufacturers for mobile terminals tried to develop a 'wide-angle lens assembly' rather than a 'telephoto lens assembly'. Google Translate of Korea Brief (see attached), at 2 (underline added).
- "… there were hardly any telephoto lens assemblies applied to mobile terminals at the time the patent invention was filed in this case." *Id.* at 2 (underline added).
- "At the time of filing for the patent in this case (around 2013), there was almost no technology for mounting a telephoto lens assembly in a portable terminal . . ." *Id.* at 6 (underline added).

Patent Owner's arguments in the Korean Brief contradict Patent Owner's arguments here that there were "well-known" miniature telephoto lens designs" or "no shortage" of miniature lens designs that would have been suitable by 2013 for the tele lens in Golan's camera. Petitioner therefore seeks to admit the Korean Brief and a certified translation into the record to show contradictory statements from Patent Owner about the availability of miniature telephoto lens designs in 2013.

Apple's counsel is available for the conference call with the Board on between 10am and 4pm, Tuesday or Wednesday, 17-18 August or otherwise at the panel's convenience. Patent Owner continues to oppose admission of the Korean Brief and translation into the IPR2020-00489 record but has not indicated its availability for the conference call.

During the discussion amongst Board and parties after yesterday's IPR2020-00906 hearing, the panel expressed concerns regarding timeline for certified translation, written briefing, and rehearing in this IPR2020-00489 proceeding. Apple is not opposed to written briefing of the good-cause-for-admission-of-new-evidence question in IPR2020-00489, provided that the panel can quickly turn a written Order and sufficiently extend the deadline for requesting rehearing without overrunning the 63-day deadline for appeal to the Federal Circuit.

David O'Brien
Partner
david.obrien@haynesboone.com

Haynes and Boone, LLP

600 Congress Avenue
Suite 1300
Austin, TX 78701-3285

(t) +1 512.867.8457
(f) +1 512.867.8613

vCard | Bio | Website

상대방 참고서면.pdf>

O'Brien, David

From: O'Brien, David
Sent: Wednesday, August 18, 2021 7:21 PM
To: Trials
Cc: Neil Rubin; Marc Fenster; James Tsuei; Jonathan Link; Shi, Hong; Ehmke, Andrew S.; Parsons, Michael
Subject: IPR2020-00489 - Request for Board Call re Admission and Extension
Attachments: APPL-1036 2021.08.02 Brief - certificate+translation+original.pdf

Thank you Mr. Kellogg and your Honors,

Petitioner has now received the **complete certified translation**, a copy of which has been provided to Patent Owner's counsel and is attached hereto. The Korean Brief addresses state of the art of miniature telephoto lenses in 2013.

In view of the conference call process provided by the Trial Practice Guide (TPG) for the panel to decide whether good cause exists for admitting the new evidence (*see* Consolidated TPG at 90), Petitioner now respectfully renews:

- its request for that conference; and
- its request that the Board extend the 30-day period of time set by § 42.71(d)(2) for the filing of a request for rehearing.
- Petitioner further requests five (5) additional pages in its rehearing request to address significance of the Korean Brief to its rehearing issues.

The Board has authority to extend the rehearing deadline at least under 37 C.F.R. §§ 42.5(c)(1,2). **Good cause** for the extension exists in view of the facts:

- that the Korean language evidence came into existence post-final written decision—just 16 days ago based on Patent Owner's own actions and briefing before the Korean Supreme Court—and was promptly brought to the attention of the panel,
- that Petitioner has diligently secured the certified translation required by § 42.63(b), and
- that, by the time the requested conference is held, less than a week will remain for filing of the Petitioner's rehearing request.

Petitioner is available for the conference with the Board on Thursday, Friday or otherwise at the panel's next opportunity. During the conference, a specific length of extension can be tailored to the circumstances.

HAYNES BOONE

David O'Brien | Partner
david.obrien@haynesboone.com | (t) +1 512.867.8457

From: Trials
Sent: Wednesday, August 18, 2021 8:01 AM
To: Neil Rubin ; Trials
Cc: Marc Fenster ; James Tsuei ; Jonathan Link ; O'Brien, David ; Shi, Hong ; Parsons, Michael ; Ehmke, Andrew S.
Subject: RE: IPR2020-00489 // Petitioner's request to admit evidence with rehearing request

EXTERNAL: Sent from outside Haynes and Boone, LLP

Counsel,

Petitioner's counsel is advised that substantive arguments are not permitted in email communications to the Board. The arguments presented in Petitioner's emails of August 13 and 17 will not be considered. As to Petitioner's request to brief

the question of whether good cause exists to admit into evidence the Korean language document at issue, given the stage of the proceedings, we decline to decide the admissibility of the Korean language document based on an incomplete, uncertified document (i.e., the Google translate files attached to Petitioner's email of August 13, 2021), the entire context of which is unclear. Petitioner may revisit this request at such time as a complete certified translation is available.

Regards,

Andrew Kellogg,
Supervisory Paralegal
Patent Trial and Appeal Board
USPTO
andrew.kellogg@uspto.gov
(571)272-7822

From: Neil Rubin <nrubin@raklaw.com>
Sent: Monday, August 16, 2021 4:04 AM
To: Trials <Trials@USPTO.GOV>
Cc: Marc Fenster <mfenster@raklaw.com>; James Tsuei <jtsuei@raklaw.com>; Jonathan Link <jlink@raklaw.com>; O'Brien, David <David.OBrien@haynesboone.com>; Shi, Hong <Hong.Shi@haynesboone.com>; Parsons, Michael <Michael.Parsons@haynesboone.com>; Ehmke, Andrew S. <Andy.Ehmke@haynesboone.com>
Subject: Re: IPR2020-00489 // Petitioner's request to admit evidence with rehearing request

Dear Honorable Board,

Counsel for Corephotonics is available after 1:00 pm Eastern on Tuesday, August 17 or after noon Eastern on Wednesday, August 18.

However, Corephotonics requests that no conference call be scheduled until Apple has made available to Corephotonics and the Board the certified translation that it seeks to have admitted into the record. The Korean document in question is a 30-page post-hearing brief, which is responding to arguments made by defendant LG and questions raised by the court in the Korean proceeding. It is addressing a patent specification, claim limitations, prior art, and a factual record that are all different than those at issue in IPR2020-00489. We do not believe that the Board can fairly judge whether this new document should be admitted based on machine translations of isolated paragraphs taken out of context.

Neil A. Rubin

RUSS AUGUST & KABAT | 12424 Wilshire Boulevard, 12th Floor | Los Angeles, CA 90025
Main +1 310 826 7474 | Direct +1 310 979 8252 | nrubin@raklaw.com | www.raklaw.com

On Aug 13, 2021, at 8:27 PM, O'Brien, David <David.OBrien@haynesboone.com> wrote:

Judges Moore, Anderson and Ullagaddi,

Petitioner writes following yesterday's oral hearing in IPR2020-00906 (before Judges Moore, Ullagaddi and Horvath) after which options for addressing a pending admission-of-new-evidence question relative to the IPR2020-00906 proceeding were discussed with the Board and amongst parties. Per the panel's

suggestion, Parties have since conferred, and Patent Owner has agreed to withdraw its opposition to authorization for Apple's motion to admit new evidence into the IPR2020-00906 proceeding. The IPR2020-00489 proceeding presents an analogous question but has a different timeline, and the Trial Practice Guide (TPG) provides a conference call process for the panel to decide the evidence question prior to rehearing. See Consolidated TPG, 90 (November 2019) ("Ideally, a party seeking to admit new evidence with a rehearing request would request a conference call ....").

Apple respectfully requests the TPG-provided conference call with the Board regarding admission into the record of Patent Owner's admissions that contradict a critical position that it has taken in this proceeding and upon which the Board relied in its final written decision. Specifically, Apple seeks admission of a brief that Patent Owner Corephotonics filed on August 2, 2021 in the Korean IPTAB proceeding titled Case No. 2020 Heo 6323 (see attached pdf, hereinafter "Korean Brief"). The Korean Brief goes not simply to the weight and credibility of expert testimony, but is a party admission, which should carry at least persuasive—if not prosecution history and judicial—estoppel effect. Apple is obtaining a certified translation as required by 37 CFR § 42.63(b). Apple's counsel is, for purposes of this request and the conference call, relying on a machine translation until a certified translation is available.

Good cause exists for including the Korean Brief in the record because (1) the Brief was filed eleven days ago, just after the Board rendered its final written decision and (2) Patent Owner's admission concerns a fundamental issue underpinning its arguments in this proceeding—and specifically contradicts its position on that issue taken here. Here, Patent Owner argued against combining Golan and Kawamura, alleging that a POSITA would have looked to numerous "well-known" miniature telephoto designs in 2013 for use in Golan's system. For example, Patent Owner argues:

- "There was also no shortage of miniature lens designs for a POSITA to use or to improve on …" POR, at 46.
- "Dr. Moore's declaration explains that it was significant, significant enough that a POSITA would have recognized that the result of scaling Kawamura was inferior in terms of materials, design, manufacturability, and performance to more current 'well-known' miniature telephoto lens designs." Sur-Reply at 14 (relying on Dr. Moore's declaration at Ex. 2003, ¶87) (underline added).
- "[T]elephoto lenses specifically for mobile phones were well-known by 2013, not that we're limited to mobile phones, but the point is that if telephoto lenses were available now in miniature lenses in 2013, why would you need to go back to Kawamura for a telephoto lens." Hearing Transcript, 29:21-24 (underline added).

In the Korean proceedings, Patent Owner admitted the opposite to the Korean Patent Office and Supreme Court: that there were almost no telephoto lens assemblies for small form factors available in 2013.

- "At the time of filing for the [Subject Patent] (around 2013) there was only one precedent document that installed a telephoto lens assembly in a mobile terminal, and most of the camera manufacturers for mobile terminals tried to develop a 'wide-angle lens assembly' rather than a 'telephoto lens assembly'. Google Translate of Korea Brief (see attached), at 2 (underline added).
- "… there were hardly any telephoto lens assemblies applied to mobile terminals at the time the patent invention was filed in this case." *Id.* at 2 (underline added).
- "At the time of filing for the patent in this case (around 2013), there was almost no technology for mounting a telephoto lens assembly in a portable terminal . . ." *Id.* at 6 (underline added).

Patent Owner's arguments in the Korean Brief contradict Patent Owner's arguments here that there were "well-known" miniature telephoto lens designs" or "no shortage" of miniature lens designs that

would have been suitable by 2013 for the tele lens in Golan's camera. Petitioner therefore seeks to admit the Korean Brief and a certified translation into the record to show contradictory statements from Patent Owner about the availability of miniature telephoto lens designs in 2013.

Apple's counsel is available for the conference call with the Board on between 10am and 4pm, Tuesday or Wednesday, 17-18 August or otherwise at the panel's convenience. Patent Owner continues to oppose admission of the Korean Brief and translation into the IPR2020-00489 record but has not indicated its availability for the conference call.

During the discussion amongst Board and parties after yesterday's IPR2020-00906 hearing, the panel expressed concerns regarding timeline for certified translation, written briefing, and rehearing in this IPR2020-00489 proceeding. Apple is not opposed to written briefing of the good-cause-for-admission-of-new-evidence question in IPR2020-00489, provided that the panel can quickly turn a written Order and sufficiently extend the deadline for requesting rehearing without overrunning the 63-day deadline for appeal to the Federal Circuit.

David O'Brien
Partner
david.obrien@haynesboone.com

Haynes and Boone, LLP
600 Congress Avenue
Suite 1300
Austin, TX 78701-3285

(t) +1 512.867.8457
(f) +1 512.867.8613

vCard | Bio | Website

상대방 참고서면.pdf>

MultiLing
A Questel Company

TRANSLATOR'S CERTIFICATE OF TRANSLATION

Translation from: Korean to English
MultiLing Project Number: RENOO2130026HQ (2021.08.02. 상대방 참고서면)
Client: Haynes and Boone, LLP

MultiLing Corporation, a Delaware corporation, with its principal office at 180 North University Avenue, Suite 600, Provo, UT 84601-4474, USA, certifies that:

a) it is a professional translation company of multiple languages, including Korean and English;
b) it has translated from the original document to the translated document identified below, and to the best of its knowledge, information, and belief the translation of that document is accurate as a publication quality translation; and further,
c) these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Original Document Identifier: 2021.08.02. 상대방 참고서면.pdf

Translated Document Identifier: 2021.08.02. 상대방 참고서면_en-US.docx

Signed this 13th day of August, 2021.

Joseph Haymore
Program Manager

ACKNOWLEDGMENT BEFORE NOTARY

State of Utah
§
County of Utah

On this 13th day of August, in the year 20219, before me (Stephanie Haymore), a notary public, personally appeared Joseph Haymore, proved on the basis of satisfactory evidence to be the person whose name is subscribed to this Translator's Certificate of Translation, and acknowledged that he or she executed the same..

IN WITNESS WHEREOF, I hereunto set my hand and official seal.

STEPHANIE ANN HAYMORE
NOTARY PUBLIC-STATE OF UTAH
COMMISSION# 712174
COMM. EXP. 05-21-2024

Notary Public, residing at Orem, UT

Written Submission

Case **2020Heo6323 Registration Invalidation (Patent)**

Plaintiff **Corephotonics Ltd.**

Defendant **LG Innotek**

Regarding the above case, the **Plaintiff's attorney** hereby submits Written Response with arguments to the Defendant's Briefs dated February 8, 2021 and May 28, 2021 as below.

Below

1. Gist of Defendant's claim and its unjustness

The Defendant stated in the Brief dated May 28, 2021 that the corrected subject invention: ① fails to meet the requirement for the supporting description and the requirement for the description to enable one to easily embody the invention; ② fails to meet the requirement for clear and concise description of the claims; and ③ includes a reason for invalidation on new matter ground.

In addition, the Defendant stated again in the Brief dated February 8, 2021 that: ④ the corrected subject invention loses inventive step in view of Reference 1 alone or Reference 1 combined with the known technology (or Prior Art in Exhibit No. Eul-5,6); and ⑤ the corrected subject invention is the same as Reference 2 and thus has a reason for invalidation on the ground of the violation of enlarged concept of novelty, because its application date is not retroactive to the priority date.

However, the Defendant's allegations are without merit.

Hereinafter, we will provide supplementary explanations to the questions asked by the board at the hearing date on June 10, 2021, and then explain in detail how the Defendant's allegations are unjust.

2. Supplementary explanation to the questions of the board on the date of hearing on June 10, 2021

A. Cameras that were applied to portable terminals at the time of filing the application of the invention of the subject patent

The invention of the subject patent is the original technology for the telephoto lens assembly mounted on a portable terminal and is widely used until now.

At the time of filing the application of the invention of the subject patent (around 2013), there was only one prior document that mounted the telephoto lens assembly on a portable terminal,[1] and most of the camera manufacturers for portable terminals were trying to develop 'wide-angle lens assembly' rather than 'telephoto lens assembly'.[2]

In paragraphs [0004] and [0005] of the specification of the subject patent, it describes that conventional lens assemblies comprising four lens elements are no longer sufficient for good quality imaging in a compact imaging lens system, and that US8,395,851 (that is, wide-angle lens assembly) using five lens elements suffers from the problem that the ratio between TTL and EFL is too large. This is because there were hardly any telephoto lens assemblies applied to portable terminals at the time the application of the invention of the subject patent was filed.

Registered Patent No. 10-1757101

Consumer demand for digital camera modules in host devices continues to grow. Cameras in cellphone devices in particular require a compact imaging lens system for good quality imaging and with a small total track length (TTL). Conventional lens assemblies comprising four lens elements are no longer sufficient for good quality imaging in such devices. The latest lens assembly designs, e.g. as in US 8,395,851, use five lens elements. However, the design in US 8,395,851 suffers from at least the fact that the ratio between TTL and an effective focal length (EFL) is too large.

[0005] Therefore, a need exists in the art for a five lens element optical lens assembly that can provide a small TTL/EFL ratio and better image quality than existing lens assemblies.

[Excerpt from the subject patent specification]

[1] Among the documents submitted by the Defendant, only one, that is, Reference 1 (Exhibit No. Eul-4) discloses the small telephoto lens assembly for portable terminals before the priority date of the invention of the subject patent. The Plaintiff has no additional information regarding this.

[2] The wide-angle cameras were applied to portable terminals in the late 1990s, and it was in the second half of 2017 when the telephoto cameras for portable terminals were actually applied. The fact that it took about 20 years until the telephoto camera were applied to portable terminal demonstrates the technical excellence of the invention of the subject patent.

In order to obtain sufficient image quality under the constrained environment of short total track length (TTL), the telephoto lens assembly applied to portable terminal required a new structure and shape different from those of the conventional telephoto lens assembly for general cameras.[3] To this end, the invention of the subject patent adopted a new structure that: ① has a short total track length (TTL≤6.5 mm); ② has a focal length (EFL) longer than the total track length; ③ has an increased refractive power of the first lens element (f1<TTL/2); and ④ has an F# of less than 2.9 (See page 2, Plaintiff's Written Submission dated November 25, 2020).

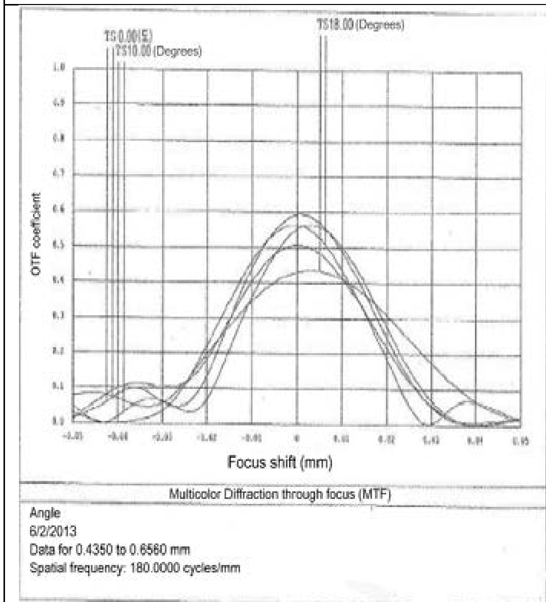
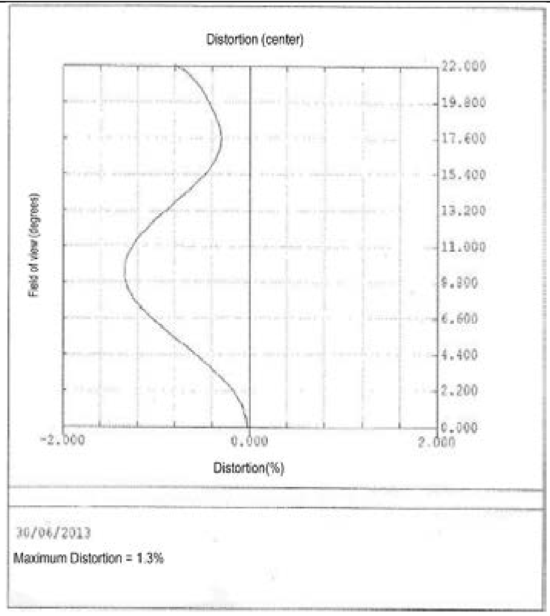
B. Relationship between the upper limit of TTL, the upper limit of F#, and the positive refractive power of the first lens element and TTL

Regarding the configuration of TTL < 6.5 mm, TTL/EFL ≤ 1, F# < 2.9, f1 < TTL/2, ① the 6.5 mm upper limit of TTL (related to TTL < 6.5 mm configuration) is related to the limit of the lens assembly according to the thickness of the portable terminal, ② the 2.9 upper limit of F# is related to the maximum incident light amount of the lens assembly, and ③ there is correlation such that TTL decreases as the positive refractive power of the first lens element increases.

However, in judging the inventive step, one should not look at whether or not each of the above configurations is individually disclosed in the prior art, but rather judge the inventive step on the basis of the overall invention in which each of the above configurations is organically combined.

In Claim 1 of the corrected subject invention, the configurations of TTL < 6.5 mm, TTL/EFL≤1, F# < 2.9, and f1 < TTL/2, and so on are **organically combined**, thus enabling a small telephoto lens assembly for portable terminal to obtain high image quality, and a high-quality image can be obtained, with a distortion error of the obtained image within 2% that is not perceptible to the human eye. This is also confirmed in the drawings of the subject patent, that is, in FIGS. 1b, 1c, 2b, 2c, 3b, 3c, and so on. FIGS. 1b and 1c are shown below as representative examples.

[3] If the telephoto lens assembly for a general camera is reduced as it is, the area of the image pickup device corresponding to the film becomes extremely narrow, and a good image cannot be obtained (See pages 19-20, Plaintiff's Written Submission dated May 25, 2021). This is also clearly stated in Exhibit No. Eul-6-1 which was submitted by the Defendant.

(FIG. 1b)	(FIG. 1c)
	
Each part of the sensor has the maximum modulus of the OTF[4] near the focal point (0 mm), so the image is clear	Showing up to 1.5% image distortion, which is less than 2% that is perceptible to the human eye

C. How low a person of ordinary skill in the art would currently consider the 'Lower limit of TTL' to be

As shown in the table below, at the time of the priority date of the invention of the subject patent (July 4, 2013), the lower limit of the thickness of the portable terminal was 6.5 mm or greater. Considering the development of the technology of parts for the operation of portable terminals and the number of lenses installed in the wide-angle and telephoto lens assemblies, the thickness of the current portable terminal (or the maximum lower limit of TTL) is estimated to be 4.5 mm to 5 mm.

[Table of thicknesses of portable terminals by portable terminal manufacturers at the time of priority date of the invention of the subject patent]

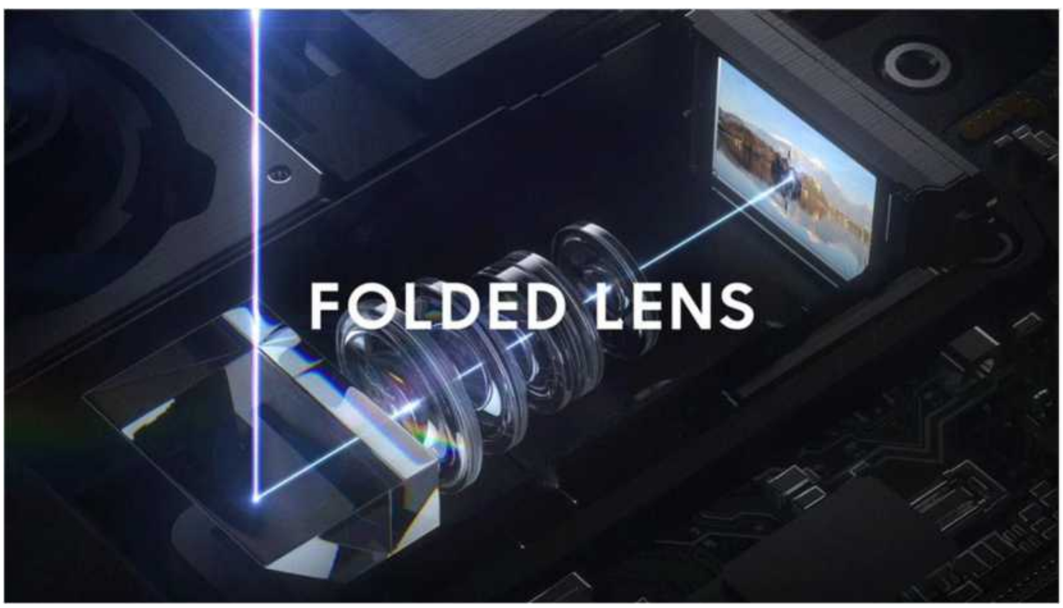
[4] OTF, which is the abbreviation of the optical transfer function, is the function that represents spatial frequency transmission capability of an optical system such as a lens, and it refers to a method of displaying resolution (Reference 1. Science Encyclopedia, search result screen for "response function")

Manufacturer	Model Name	Release Date	Smartphone Thickness	Remark
OPPO	X907	2012.06	6.65 mm	Reference 2
Fujitsu	Arrows ES IS12F	2012.01	6.7 mm	Reference 3
Huawei	Ascend Pls	2012.01	6.68 mm	Reference 4
Apple	iPhone 5	2012.09	7.6 mm	Reference 5
Samsung	Galaxy S4	2013.03	7.9 mm	Reference 6
SONY	Xperia Z Ultra	2013.06	6.5 mm	Reference 7

In recent years, technologies have been developed to overcome limitations due to the thickness of portable terminals by adopting a method of bending the lens arrangement direction at right angles from the thickness direction to the width direction of the portable terminal, or a method of increasing the number of cameras.

Reference 8. Samsung Homepage Folded Lens Screen

The lens requires additional space for its vertical structure, and this makes the camera thicker. However, since the folded lens uses a prism like the periscope principle, it can sit flat on the bottom of the smartphone camera. When the light entering through the back of the smartphone is transmitted to the lens by the prism, the folded lens having the lens structure horizontally aligned inside the phone refracts the light by 90 degrees to increase the focal length. In this way, the height and width of the camera are reduced, realizing the innovative zoom performance of the Galaxy S20 Ultra.



Considering the thickness of the portable terminal currently expected by those of ordinary skill in the art (4.5 mm to 5 mm as the lower limit of TTL), the judgment of the trial decision (or the allegation of the creditor) that "the detailed description of the subject patent is not described in

such a manner that enables one to easily embody the TTL close to zero (0.1 mm or less) and F# close to zero (10^{-3} or less)" is entirely meritless, as it assumes extreme cases that undermine the technical significance of the invention of the subject patent.[5]

D. Regarding how the numerical values of configurations of the 6.5 mm upper limit of TTL and the 2.9 upper limit of F# of Claim 1 of the corrected subject invention are set

A very important consideration for **the compact telephoto lens assembly mounted on the portable terminal** is the thickness (the length of TTL) of the compact portable terminal to which the telephoto lens assembly is mounted, which is different from the general lens assembly that has no particular restrictions on the length of the TTL. Another important consideration is whether the small telephoto lens assembly can provide a large amount of light to realize high-definition image, but this is not a problem for the conventional wide-angle lens assembly with a short focal length because it would not have a lack of amount of light. In other words, for the telephoto lens assembly mounted on a small portable terminal, the values of TTL and F# have technical significance at their upper limits.

At the time of filing the invention of the subject patent (around 2013), there was almost no technology for attaching the telephoto lens assembly to the portable terminal, and the inventors of the invention of the subject patent studied a compact telephoto lens assembly that can be mounted to the compact portable terminal and obtain high quality image and, as a result, arrived at the optimal upper limit of TTL and upper limit of F#.

The numerical range of TTL can be derived from the statement[6] "TTL is smaller than the EFL" in the Detailed Description of this patent and the TTL values of the Examples.

That is, in the embodiments where TTL < EFL and EFL = 6.90 mm (Embodiment 1), 7 mm (Embodiment 2), and 6.84 mm (Embodiment 3), sufficiently high-quality images were obtained at least at TTL < 7 mm. In addition, in the embodiments, it was confirmed that good images can still be obtained even with TTL=5.904 mm (Embodiment 1), 5.90 mm (Embodiment 2), and 5.904 mm (Embodiment 3) which are thinner, and then <u>the upper limit of TTL was reduced to</u>

[5] The Patent Court's Decision 2018 Heo 2700 on August 30, 2018 ruled that "it is not acceptable to assume the extreme cases that undermine the technical significance of the invention of the subject patent and require the description of the invention describe even those cases to the extent that they can be embodied".

[6] Exhibit No. Kap-3 paragraph [0009]

6.5 mm that is smaller than 7 mm so that a sufficiently good image can be obtained even when the elements are organically combined.[7]

Regarding F#, the condition of F#<2.9 is derived from the description "the lens assembly has an F number F#<3.2" (Exhibit No. Kap-3 paragraph [0009]) and from F# = 2.80 (Embodiment 1), 2.86 (Embodiment 2), and 2.80 (Embodiment 3) (as the embodiments for obtaining a sufficient amount of light to obtain good image quality in a compact telephoto lens assembly for a portable terminal where TTL is 6.5 mm or less and TTL/EFL is less than 1). Meanwhile, since the image sensor used in portable terminals has a size limitation, the upper limit of F# is limited to 2.9 that is smaller than 3.2 to ensure sufficient amount of light even when the number of pixels of the image sensor is increased[8] to enhance resolution under limited area conditions.

E. Whether it is a technical problem to make the TTL smaller and the F# smaller in light of the common sense in the technical field of lenses

Since the technical concept of the telephoto lens assembly for a portable terminal was different from the general telephoto camera in many ways, at the time of filing for the invention for the subject patent, a person of ordinary skill in the art did not think that the telephoto lens assembly could be installed in the portable terminal. Therefore, a person skilled in the art at the time was not even aware of the "technical problem of having a small TTL, while making TTL smaller than EFL and making F# smaller" as a technical problem to develope a telephoto lens assembly for a portable terminal.

Also, at the time of filing for the invention of the subject patent, the person of ordinary skill in the art was not able to anticipate that the telephoto lens assembly for a portable terminal, which "has a small TTL that allows installation in the portable terminal, while having the TTL smaller than EFL and having a smaller F#", can obtain good images as shown in FIGS. lb, 1c, 2b, 2c, 3b and 3c.

If one deems that "having a small TTL that allows installation in the portable terminal, while making TTL smaller than EFL and making F# smaller" is a general technical problem in this

[7] This indicates the fact that the invention of the subject patent is used for the portable terminals, and that it is such a telephoto lens assembly that, unlike the **typical telephoto camera**, is good to be mounted to a very thin terminal, that is, to the portable terminal with the thickness (6.5 mm or larger) at the time of priority date of the invention of the subject patent.

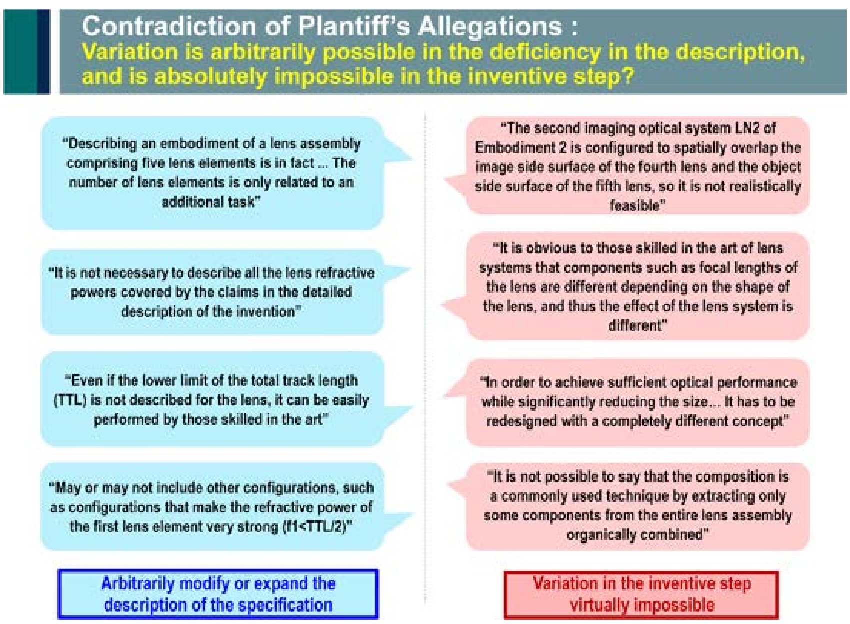
[8] Each pixel becomes smaller.

field based on the present time when the telephoto lens assemblies for portable terminals are generally used, this is a typical hindsight bias, since he judges so based on hindsight on the premise that a person skilled in the art is aware of the technology disclosed in the specification of the subject patent.

3. Refutation to Defendant's claim

A. There is no contradiction in the Plaintiff's arguments for the lack of description and the inventive step.

According to the Defendant, the Plaintiff made contradictory arguments by saying that, for the inventive step, a person skilled in the art cannot arbitrarily change the configuration of the lens assembly, whereas against the lack of description, the configuration of the lens assembly can be arbitrarily changed (see page 70, Defendant's argument dated June 10, 2021).



[page 70, Defendant's argument dated June 10, 2021]

However, the Defendant's allegation is without merit.

<u>Enablement requirement (that is, lack of description)</u> is a test to determine whether or not a person skilled in the art can easily embody the invention described in the claim <u>by referring to the description of the **specification of the patented invention and the level of technology at**</u>

the time of filing. Therefore, it is not technically difficult for a person skilled in the art to modify the rest of the lens configurations based on the core configuration proposed by the patented invention by referring to the technical level at the time of filing and the description of the specification of the subject patent.

On the other hand, **whether there is difficulty of configuration (that is, inventive step)** is a test to determine whether it is easy for a person skilled in the art without knowledge of the configuration of the invention of the subject patent to derive the configuration of the invention of the subject patent from the **earlier inventions** at the time of filing. Since there is a fundamental difference in the technical idea between the invention of the subject patent and the References, and since the specific configurations are also different, a person skilled in the art cannot derive all or part of the configuration of the invention of the subject patent from the References (or by modifying configurations of the References).

Therefore, the Plaintiff's argument is not contradictory at all.

B. The Defendant's assertion that the invention of the subject patent is not supported by the detailed description of the invention is without merit.

(1) The Defendant argues that since the refractive power combination (positive/negative/negative/positive/negative) of the five lens elements is specifically described in the detailed description of the subject patent, the configuration of the lens assembly of a different combination is not supported by the detailed description of the invention (Defendant's Brief dated May 28, 2021 pages 3 to 5).

However, all of the Defendants' above arguments are without merit.

(2) With regard to the number of lenses, the technical problem of the invention of the subject patent is not limited to the combination of the refractive power of the five lens elements, but is to provide a compact telephoto lens assembly for a portable terminal which is thin (with a smaller TTL/EFL ratio) and capable of obtaining good images (for details, see pages 3 to 17, Plaintiff's submission dated February 18, 2021).

The detailed description of the subject patent describes the need for a compact telephoto lens assembly capable of obtaining a good image with a thin thickness even when it exceeds four lens

elements (Exhibit No. Kap-3 paragraphs [0004], [0005]), and it does not necessarily limit to the optical lens assembly of five lens elements.

In addition, the subject patent simply states that the purpose of the patent is to provide a small telephoto lens assembly that can solve the conventional problems as the "problem to be solved", and it does not limit the number of lens elements (Exhibit No. Kap-3 paragraph [0006]).

Furthermore, since the invention of the subject patent describes an optical lens assembly comprising a 'fifth lens element' in the form of an open claim as an 'embodiment' (Exhibit No. Kap-3 paragraph [0007]), it does not limit the number of lens elements to five.

According to the Defendant's argument, all configurations of the lens assembly described as the embodiments in the detailed description of the invention should be described in the independent claim, but this is against the Enforcement Decree of the Patent Act[9] stipulating that the invention can be divided and entered as independent and dependent claims and the Supreme Court ruling that "the configuration described in the claims does not necessarily have to be described in the detailed description or drawings of the invention" (Supreme Court Decision[10] 2003Hu2072 on November 24, 2006).

We note the Defendant himself has also registered a number of patents based on the claims further specifying the invention described as an embodiment in the detailed description of the invention.[11]

(3) With regard to the refractive power combination, when considering the technical level at the time of filing of the invention of the subject patent and the description of the subject patent specification, details of 'a pair of second and third lens elements having negative optical power together' of the invention of Claim 35 of the subject case are either described in the detailed

[9] Article 5(1) of Patent Act Enforcement Decree

[10] "As long as the invention of the subject patent is described in such a manner that allows addition of other technologies to the elements explicitly described in the claims, although the detailed description or drawings of the embodiments of the inventions of Claims 17 to 22 of this case are expressed by adding a 'step of separating words and postpositions' which is not described in the claims, it should not be said that the inventions of Claims 17 to 22 mentioned above are not supported by the detailed description only under such circumstances."

[11] See Exhibit Nos. Kap-10 and 11, each of the registered patent publications, and pages 4 to 6 of the Plaintiff's Brief dated February 18, 2021.

description and drawings of the subject patent, or fully recognizable by those skilled in the art from the specification of the subject patent (Plaintiff's Brief dated February 18, 2021 pages 9 to 10).

Specifically, the detailed description of the subject patent states, "The relatively large distance between the third and the fourth lens elements plus the combined design of the fourth and fifth lens elements assist in bringing all fields' focal points to the image plane" (Exhibit No. Kap-3 paragraph [0011]) and "the focal length of the first lens element f1 with positive refractive power is smaller than TTL/2" (Exhibit No. Kap-3 paragraph [0009]).

This means that the light is refracted as it passes through the first lens element with positive refractive power (i.e., the converging lens) to be converged strongly at one point, and therefore, it has to travel relatively a long distance (a long distance between the third and fourth lens elements) until it passes through the fourth lens element.

That is, anyone skilled in the art can easily figure out that, in order for the light to travel a long distance between the third and fourth lens elements and arrive at the fourth lens element, **it is essential that the second lens element and the third lens element perform the function of a concave lens (negative refractive power) to spread light**.

Also, the fact that f2 of the second lens element and f3 of the third lens element may have a positive or negative value, respectively, correctly matches the description in the detailed description of the subject patent stating, "the minimal chromatic aberration are obtained by fulfilling the relationship 1.2x|f3| > |f2| > 1.5xfl", where the values are expressed as absolute numbers (Exhibit No. Kap-3 paragraph [0010]).

C. Even if the lower limit of the TTL and F# values are not specified in the claims, a person skilled in the art can embody the corrected subject invention.

The Defendant asserts that, without having the upper or lower limit of the numerical range set, a person skilled in the art cannot easily embody the invention described in the claims (Defendant's Brief dated May 28, 2021 pages 7 to 10).

However, the Defendant's above allegation is also without merit.

First of all, it can be assumed that a person skilled in the art in the subject case is “a person who has completed a master’s course in lens assembly technology and has about 2 to 3 years of industry experience”.

The Defendant's assertion that a person skilled in the art cannot embody the invention of the relevant lens assembly just because the lower limit of TTL or F# is not stated seems far-fetched.

As described above, the technical significance of the invention of the subject patent lies in the upper limit of TTL and F#, and for the lower limit of TTL and the lower limit of F#, a person skilled in the art can easily set as needed by considering physical limitations such as thickness and amount of light of the portable terminal.

Therefore, as long as the technically important numerical value of the upper limit is specified, a person skilled in the art can of course practice the invention of the subject patent.[12]

The similar cases from the patent offices in many other countries also agree that it is possible to embody the invention even when the configuration of the lower limit of TTL or F# is not described in the claims (Exhibit Nos. Kap-9, 28 to 34).

If it is required to list all the possible numerical ranges as argued by the Defendant, it will lead to an unfair conclusion that the inventor should perform a number of unnecessary experiments to find meaningless lower limits.[13]

D. The numerical ranges of TTL or F# of the invention of the subject patent are supported by the detailed description of the invention.

The Defendant asserts that the invention of the subject patent fails to specify the lower limits of the numerical range of TTL (TTL $\leq$ 6.5 mm) and the numerical range of F# (F# < 2.9), and therefore, fails to meet the description requirement for the lack of support (Defendant's Brief dated May 28, 2021 page 6).

However, the Defendant’s above allegation is also without merit.

[12] Patent Court Decision 2012Heo6700 on January 25, 2013 also ruled that it would be sufficient to specify only the upper limit or lower limit of the technically important numerical value, and it should not be said that the invention is unclear just because the technically insignificant lower limit or upper limit is not specified.

[13] In fact, it may not even be possible to ascertain whether there is any critical significance at the lower limit of such (meaningless) figures.

The Supreme Court consistently ruled that "whether a claim is supported by the detailed description of the invention should be judged by whether or not the matters corresponding to the matters described in the claims are described in the detailed description of the invention from the standpoint of those skilled in the art." (Supreme Court Decision 2012Hu832 on September 4, 2014).

A person skilled in the art designing a lens system for a portable terminal will immediately recognize from the upper limit of the TTL that the invention of the subject patent is applied to a small portable terminal with a very thin thickness, and also easily understand that the upper limit of F# requires a sufficient amount of light in order to obtain good image quality with the small telephoto lens assembly for a portable terminal.

Specifically, as explained in the Plaintiff's Brief dated February 18, 2021 (page 26) and in this Written Submission (pages 6 to 7, Section 2. D), the configuration of "TTL≤6.5 mm" is derived from the description "TTL is smaller than the EFL" in the detailed description of the subject patent (Exhibit No. Kap-3 paragraph [0009]), and the EFL values in each of the embodiments (6.90 mm, 7 mm, 6.84 mm), and the TTL values in each of the embodiments (5.904 mm, 5.90 mm, 5.904 mm). Therefore, the claims for the corrected subject invention are limited within the scope of the detailed description of the invention, and since the corresponding configuration is described in the detailed description of the invention, the configuration is fully supported by the detailed description of the invention.

Furthermore, with respect to the numerical range of F#, <u>"the configuration of the lens assembly having an F# smaller than 2.9"</u> is derived from the description <u>"the lens assembly has an F number F# < 3.2" in the means to solve the problem of the patented invention (Exhibit No. Kap-3 paragraph [0009])</u> and the F# values (2.80, 2.86, 2.80) in each of the Embodiments. The above configuration narrows the numerical range to sufficiently provide a large amount of light for high-definition realization within the numerical range described in the detailed description of the subject patent, and accordingly, it is also supported by the detailed description of the invention in the literal sense.

In addition, in light of the Patent Office Examination Guidelines[14], which stipulates that the matters listed as claims in the claim part are the matters that the applicant wishes to be protected by the patent right on his/her own will among the inventions disclosed in the description of the invention, or the decision[15] ruling that the applicant can freely decide which elements to describe in the claim part, the claims of the invention of the subject patent, which are selected within the numerical ranges described in the detailed description of the subject patent, are supported by the detailed description of the invention.

The Patent and Utility Model Examination Guidelines state that, when determining whether the claims are supported by the detailed description of the invention or not, this is done by mainly reviewing whether the claim is outside the scope that a person with ordinary skill in the relevant technical field can grasp from the description of the invention.

Exhibit No. Kap-35 Patent/Utility Model Examination Guidelines (Amendment December 14, 2020. Patent Office Regulation No. 117)
Whether corresponding matters are described in the description of the invention should be <u>judged by examining whether or not an invention is being claimed in the claims beyond the scope of the invention that can be understood by those skilled in the art in consideration of the purpose of Article 42(4)1 from the description of the invention</u>, rather than by examining the claims and the description of the invention are identical in text.

14

See lower half of page 2402 of Exhibit No. Kap-35, "2. Acknowledgement of the Invention"
Matters listed as claims in the claim part are the matters for which the applicant wishes to be protected by the patent right on his/her own will among the inventions disclosed in the description of the invention in accordance with the claim description method of Articles 42(4) and (8) of the Patent Act.

15

Patent Court Decision 2009Heo4742 on December 24, 2009
Article 42(4)(3) of the Old Patent Law, which requires that the claims of the patented invention describe only the matters essential to the constitution of the invention, should only be understood as not only forbidding to interpret, after grant, the scope with other elements that were not described at the time of grant as if such elements were originally described in the claims on the basis of the absence of the description of elements necessary for the constitution of the invention of the corresponding patent, but also confirming the fact that all the elements described in the claims should be understood as essential elements and that no element should be viewed as non-essential element due to their low importance (see Supreme Court Decision 2003Hu2072 on November 24, 2006), and <u>it cannot be regarded as a regulation requiring that all the configurations necessary to achieve the purpose and effect of the patented invention be described in the claims, and it can be said that the applicant can freely decide which elements are described in the claims, taking into consideration whether to narrow or broaden the technical scope of the invention,</u> and apart from the fact that one cannot obtain a patent registration for reasons such as an incomplete invention or lack of inventive step <u>when he or she fails to describe some of the elements that are deemed necessary for achieving the purpose and effect of the patented invention in the claims, the above cannot be based to say that a patent registration cannot be obtained for violation of Article 42(4)3 of Old Patent Law.</u>

Furthermore, the Patent Court ruled that "It is not necessary to describe all the embodiments supporting the claims in the specification of the patented invention, so even if the embodiments related to the four-way confirmation are not described, this cannot be the reason for lack of description (Patent Court Decision 2011Heo620 on August 10, 2011).

Therefore, the TTL or F# numerical range of the subject patent is fully supported by the detailed description of the invention, and the Defendant's claim to the contrary is without merit.

E. The TTL or F# numerical range of the subject patent are clearly and concisely stated in the claims.

The Defendant asserts that the TTL or F# numerical range has no lower limit, so the claims are not clearly and concisely stated (Defendant's Brief dated May 28, 2021 pages 10 - 11).

However, for the subject patent, it cannot be considered that there is reason for invalidity of lack of description because the lower limit of the numerical range is not described.

As explained above, the subject patent has technical significance at the upper limits of TTL and F#. Therefore, even if there is no description of the lower limits of TTL and F# in the subject patent, a person skilled in the art can clearly grasp the subject patent as the upper limit of TTL and F#.

Moreover, <u>the subject patent limits the upper limits of TTL and F# and rather limits the scope of the subject patent to a narrower range with respect to TTL and F#, which does not make the invent unclear compared to the conventional skills due to such a numerical range.</u>

Therefore, the defendant's claim is also without merit.

F. The invention of the subject patent has no reason for invalidation on new matter ground.

The Defendant claims that 'TTL numerical range' and 'F# numerical range' of the subject patent and 'the configuration of combined refractive power of the second and third lens elements' were added by amendment during the course of the application, so they correspond to the addition of new matters (Defendant's Brief dated May 28, 2021 page 11).

However, the above defendant's claim is without merit.

The TTL and F# of the subject patent are within the scope of the matters described in the priority application specification.

Specifically, on page 2, lines 11-13 of the priority application specification, 'TTL is smaller than the EFL' is written in parallel with 'the TTL/EFL ratio is smaller than 0.9' along with the conjunction 'and'.

> The effective focal length of the lens assembly is marked EFL and the total track length on an optical axis between the object-side surface of the first lens element and the electronic sensor is marked TTL. In all embodiments, TTL is smaller than the EFL and the TTL/EFL ratio is smaller than 0.9. In an embodiment, the TTL/EFL ratio

[Exhibit No. Eul-7, page 2]

Since both 'TTL<EFL' and 'TTL/EFL < 0.9' are included in the priority application specification, the original text of the priority application explicitly discloses 'TTL/EFL < 1.0.

On the other hand, since the EFL values (6.9 mm, 7 mm, 6.84 mm),[16] TTL/EFL < 1.0 configuration is described in priority application specification, TTL ≤ 6.5 mm is also within the above numerical range.

Even when looking at the claims initially attached to the patent application, claim 10 states that "the lens assembly has an F number less than 3.2" (Exhibit No. Eul-3-1, page 22), and the detailed description also presents "F# < 3.2" and each embodiment "F# = 2.80, 2.86, 2.80" (Exhibit No. Kap-3, [0009], [0020], [0026], [0032]), so it is clear that F# < 2.9 is within the numerical range of the claims initially attached to the patent application.

16

Exhibit No. Eul-7 Pages 6, 8, 10
Embodiment **100** provides a field of view (FOV) of 44 degrees, with EFL = 6.90mm, F# = 2.80 and TTL of 5.904 mm. Thus and advantageously, the ratio TTL/EFL = 0.855. Advantageously, the Abbe number of the first, third and fifth lens element is Embodiment **200** provides a FOV of 43.48 degrees, with EFL = 7 mm, F# = 2.86 and TTL = 5.90 mm. Thus and advantageously, the ratio TTL/EFL = 0.843.
Embodiment **300** provides a FOV of 44 degrees, EFL = 6.84 mm, F# = 2.80 and TTL = 5.904 mm. Thus and advantageously, the ratio TTL/EFL = 0.863. Advantageously,

[Claim 10] The optical lens assembly of claim 1, wherein the lens assembly has an F number smaller than 3.2.

[Exhibit No. Eul-3-1 page 22]

[0009]	TTL is defined as the distance on an optical axis between the object-side surface of the first lens element and the image sensor. “EFL" has its regular meaning. In all embodiments, TTL is smaller than the EFL, i.e. the TTL/EFL ratio is smaller than 1.0. In some embodiments, the TTL/EFL ratio is smaller than 0.9. In an embodiment, the TTL/EFL ratio is about 0.85. In all embodiments, the lens assembly has an F number F# < 3.2. In an embodiment, the focal length of the first lens element fl is smaller than TTL/2,
[0020]	Embodiment 100 provides a field of view (FOV) of 44 degrees, with EFL = 6.90 mm, F# = 2.80 and TTL of 5.904 mm.
[0026]	Embodiment 200 provides a FOV of 43.48 degrees, with EFL = 7 mm, F# = 2.86 and TTL = 5.90mm. Thus and advantageously,
[0032]	Embodiment 300 provides a FOV of 44 degrees, EFL = 6.84 mm, F# = 2.80 and TTL = 5.904 mm. Thus and advantageously,

[Exhibit No. Kap-3 paragraphs [0009], [0020], [0026], [0032]]

In the priority application specification {Exhibit No. Eul-7 page 2 line 13 - page 3 line 5 (original text), page 29 line 14 - page 30 line 13 (translation)}, the technical descriptions corresponding to the detailed description paragraphs [0009] - [0011] of the subject patent are described. Therefore, the configuration of combined refractive power of the second and the third lens elements’ is also described in the first specification etc.

[0009]	TTL is defined as the distance on an optical axis between the object-side surface of the first lens element and the image sensor. “EFL" has its regular meaning. In all embodiments, TTL is smaller than the EFL, i.e. the TTL/EFL ratio is smaller than 1.0. In some embodiments, the TTL/EFL ratio is smaller than 0.9. In an embodiment, the TTL/EFL ratio is about 0.85. In all embodiments, the lens assembly has an F number F# < 3.2. In an embodiment, the focal length of the first lens element fl is smaller than TTL/2, the first, third and fifth lens elements have each an Abbe number ("Vd") greater than 50, the second and fourth lens elements have each an Abbe number smaller than

30, the first air gap is smaller than d2/2, the third air gap is greater than TTL/5 and the fourth air gap is smaller than 1.5ds. In some embodiments, the surfaces of the lens elements may be aspheric.

[0010] In an optical lens assembly disclosed herein, the first lens element with positive refractive power allows the TTL of the lens system to be favorably reduced. The combined design of the first, second and third lens elements plus the relatively short distances between them enable a long EFL and a short TTL. The same combination, together with the high dispersion (low Vd) for the second lens element and low dispersion (high Vd) for the first and third lens elements, also helps to reduce chromatic aberration. In particular, the ratio TTL/EFL < 1.0 and minimal chromatic aberration are obtained by fulfilling the relationship 1.2x|f3| > |f2| > 1.5xfl, where "f" indicates the effective focal length of the lens element and the numerals 1, 2, 3, 4, 5 indicate the number of the lens elements.

[0011] The relatively large distance between the third and the fourth lens elements plus the combined design of the fourth and fifth lens elements assist in bringing all fields' focal points to the image plane. Also, because the fourth and fifth lens elements have different dispersions and have respectively positive and negative power, they help in minimizing chromatic aberration.

[Exhibit No. Kap-3 paragraphs [0009]-[0011]]

The effective focal length of the lens assembly is marked "EFL" and the total track length on an optical axis between the object-side surface of the first lens element and the electronic sensor is marked "TTL". In all embodiments, TTL is smaller than the EFL, i.e. the TTL/EFL ratio is smaller than 0.9. In an embodiment, the TTL/EFL ratio is about 0.85. In all embodiments, the lens assembly has an F number F# < 3.2. In an embodiment, the focal length of the first lens element f1 is smaller than TTL/2, the first, third and fifth lens elements have each an Abbe number ("Vd") greater than 50, the second and fourth lens elements have each an Abbe number smaller than 30, the first air gap is smaller than $d_2/2$, the third air gap is greater than TTL/5 and the fourth air gap is smaller than $d_5/2$. In some embodiments, the surfaces of the lens elements may be aspheric.

In an optical lens assembly disclosed herein, the first lens element with positive refractive power allows the TTL of the lens system to be favorably reduced. The combined design of the first, second and third lens elements plus the relatively short distances between them enable a long EFL and a short TTL. The same combination, together with the high dispersion (low Abbe number) for the second lens element and low dispersion (high Vd) for the first and third lens elements, also helps to reduce chromatic aberration. In particular, the ratio TTL/EFL<1.0 and minimal chromatic aberration are obtained by fulfilling the relationship 1.2×|f3|>|f2|>1.5×f1, where "f" indicates the effective focal length of the lens element and the numerals 1, 2, 3, 4, 5 indicate the number of the lens elements.

[0011] The relatively large distance between the third and the fourth lens elements plus the combined design of the fourth and fifth lens elements assist in bringing all fields' focal points to the image plane. Also, because the fourth and fifth lens elements have different dispersions and have respectively positive and negative power, they help in minimizing chromatic aberration.

[Exhibit No. Eul-7 page 29 line 14 - page 30 line 13]

It was judged that the amendments 1 to 13 were made within the scope of the matters described in the specification or drawing of the subject patent, and this is extremely reasonable.[17]

As a result, the Defendant's allegations are without merit, so the corrected invention has no reason for invalidation on new matter ground.

G. In the corrected subject invention, the inventive step is not denied Reference 1 alone or Reference 1 combined with the known technology (or Prior Art in Exhibit No. Eul-5,6).

The Defendant stated that in the corrected subject invention, the inventive step is denied in view of Reference 1 alone or Reference 1 combined with the known technology (or Prior Art in Exhibit No. Eul-5,6)(the Defendant's Briefs dated February 8, 2021).

However, the Defendant's allegations are without merit.

(A) Reference 1 is impossible to implement and it is difficult for a person skilled in the art to grasp its technical contents, so it cannot be used as a preparation for the judgment of inventive step.

As explained on the pages 3-6, Plaintiff's Written Submission dated June 3, 2021, the second imaging optic system LN2 of the Embodiment 2 of Reference 1 is configured to have the image side surface of the fourth lens and the object side surface of the fifth lens overlap spatially, making it impossible to implement in practice. This is also acknowledged by The Defendant.

It is also difficult for a person skilled in the art to grasp the above configuration as a feasible invention.

17

Exhibit No. Kap-1, Written Judgement page 13
The amendments 1 to 13 correspond to a reduction of scope of the claims, and are made within the scope of the matters described in the specification or drawings of the subject patent, and because there is no change occurred due to above amendments 1 to 13 in terms of purpose or effect of the subject patent, it cannot be considered that the subject patent is substantially expanded or changed, and accordingly, the request for correction of the subject case is acknowledged to be the legitimate amendment that satisfies Articles 136(1), (3) and (4) of Patent Act applied by Articles 133(2)(1) and (4) of Patent Act.

Therefore, Reference 1 cannot be compared in the judgment of inventive step.

(B) Even if Reference 1 can be comparable, the inventive step is not denied by Reference 1 of the corrected subject invention.

In the corrected subject invention, 'the configuration in which the focal length of the first lens element f1 is smaller than TTL/2', 'the configuration in which the first lens element has convex object-side surface and convex image-side surface', and 'the configuration in which the F# of the lens assembly is less than 2.9' are different those of Reference 1, which is not disputed between the parties.

The Defendant stated that 'the configuration in which the focal length of the first lens element f1 is smaller than TTL/2' can be derived based on "1.0<fFw/fFm < 1.5 - conditional equation (1)" disclosed in paragraph [0019] of Reference 1, and 'the configuration in which the first lens element has convex object-side surface and convex image-side surface' has no technical meaning, and claimed that 'the configuration in which the F# of the lens assembly is less than 2.9' is a meaningless numerical limitation that has no technical substance.

However, as explained on pages 6-14, Petitioner's Written Submission dated June 3, 2021, the Defendant's allegations are unreasonable.

1) Regarding the configuration in which the focal length f1 of the first lens element is smaller than TTL/2

Paragraph [0019] of Reference 1 claimed by the Defendant has the following description.

Exhibit No. Kap-3, Written Judgement page 13
[0019] "1.0<fFw/fFm<1.5 ...(1) wherein fFw: Combined focal length of the first lens and the second lens in the first imaging optical system, fFm: Combined focal length of the first lens and the second lens in the second imaging optical system" [0024] "Exceeding the lower limit of the conditional equation 1 means that the focal length of the front group of the second imaging optical system is shorter (that is, the power is stronger) than the focal length of the front group of the first imaging optical system. That is, since the focal length of the

entire system of the second imaging optical system is relatively long, the positive power is weakened as a whole, but on the contrary, the lower limit defines the conditions under which the power is stronger than that of the front group of the first imaging optical system having a short focal length of the entire system. By satisfying this conditional equation 1, the telephoto tendency of the second imaging optical system can be strengthened, so that the effect of reducing the overall length of the device can be obtained."

[Exhibit No. Eul-4, translation of paragraphs [0019] and [0024]]

By the way, the above conditional equation 1 relates to the combined focal length of the first lens and the second lens, not the focal length of the first lens.

For example, the specification of Reference 1 mentioned by the Defendant (Exhibit No. Eul-4 paragraphs [0019] and [0024], marking yellow) also discloses only the combined focal length of the first lens (L1) and the second lens (L2), and the focal length of the first lens (L1) is not described separately.

Also, the above paragraph of Reference 1 does not describe the configuration for making f1 smaller than TTL/2. Rather, all of the embodiments disclosed in Reference 1 have f1 greater than TTL/2 (See, Exhibit No. Eul-4 paragraph [0076], marking yellow[18]).

Exhibit No. Eul-4 [0076] Table 1

		Embodiment 1		Embodiment 2	
		LN1	LN2	LN1	LN2
Focal length of the entire system [mm]	fw or fm	2.73	4.32	3.70	5.51
Fno	FNOw or FNOm	4.00	4.00	3.00	4.00
Lens overall length (infinity) [mm]	TLw or TLm	3.04	3.65	4.45	4.91
Maximum image height [mm]	2Y'	5.12	5.12	5.80	5.80
Full angle of view [deg]	2ωw or 2ωm	86.329	61.28	76.18	55.52
L1 Focal length [mm]	f1w or f1m	2.60	2.10	2.47	2.54

[18] According to Exhibit No. Eul-4 paragraph [0076] Table 1, in Embodiment 1, f1 is 2.1, which is higher than TTL/2, 1.825(=3.65/2), and in Embodiment 2, f1 is 2.54, which is higher than TTL/2, 2.455(=4.91/2).

2) Regarding to 'the configuration in which the first lens element has convex object-side surface and convex image-side surface'

The Defendant stated that whether the image-side surface of the first lens element is concave or convex has no technical meaning in relation to the corrected subject invention, so that the above configuration can be easily derived by a person skilled in the art by any selection.

However, it is obvious to those skilled in the art of lens systems that components such as the focal length of the lens are different depending on the shape of the lens, and thus the effect of the lens system is different. Therefore, it is obvious that the shape of the lens has technical significance in the design of the lens system.

All of the telephoto optical systems of Reference 1 adopt a characteristic configuration in which the image-side surface of the first lens element is concave, and on the contrary, there is no motivation for changing the image-side surface of the first lens element into a convex shape.

3) Regarding to 'the configuration in which the F# of the lens assembly is less than 2.9'

The Defendant stated that 'the configuration having F# less than 2.9' is a meaningless numerical limitation that has no technical substance.

However, as mentioned above, the configuration that limits the minimum amount of light in the requirements of F# is a configuration that is adopted considering that a sufficiently large amount of light is required for high-definition implementation, which is a characteristic configuration of the corrected subject invention regarding 'small telephoto lens assembly'. It is different from the conventional wide-angle optical system having a short focal length.

In Reference 1, F# is described as characteristic element in claim 7[19].

[19]

Exhibit No. Eul-4 page 30
[7] The imaging device of any one of claims 1 to 6, characterized by satisfying the following conditional equation 5. 0.6<FNOw/FNOm< 1.3 … (5) wherein FNOw: F number of the first imaging optic system, FNOm: F number of the second imaging optic system.

YULCHON 律村 법무법인(유) 율촌

Therefore, the Defendant's allegations are without merit.

On the other hand, in Reference 1, it is described that it is more advantageous to achieve downsizing of the whole to make the second imaging optical system darker than the first imaging optical system (Exhibit No. Eul-4 paragraph [0038]), The specific values of F# of the first imaging optical system (wide angle) and the second imaging optical system (telephoto) in each embodiment are described (Exhibit No. Eul-4 paragraph [0076]).

Exhibit No. Eul-4 paragraphs [0037] and [0038]

【0037】

It is preferable to satisfy the following conditional equation 5.

0.6<FNOw/FNOm< 1.3 ... (5)

wherein

FNOw: F number of the first imaging optic system.

FNOm: F number of the second imaging optic system.

【0038】

If the F-number is significantly different at the time of switching, the impression of blurring will change significantly, which will be unnatural for the user, so F number is preferable to be close to the first, second imaging optic systems in order to satisfy conditional equation 5. It is advantageous to make the second imaging optical system darker than the first imaging optical system in order to achieve overall miniaturization.

Exhibit No. Eul-4 paragraph [0076]

		Embodiment 1		Embodiment 2	
		LN1	LN2	LN1	LN2
Focal length of the entire system [mm]	fw or fm	2.73	4.32	3.70	5.51
Fno	FNOw or FNOm	4.00	4.00	3.00	4.00
Lens overall length (infinity) [mm]	TLw or TLm	3.04	3.65	4.45	4.91
Maximum image height [mm]	2Y'	5.12	5.12	5.80	5.80

Full angle of view [deg]	2ωw or 2ωm	86.32	61.28	76.18	55.52

"0.6<FNOw/FNOm<1.3 ... (5)" described in paragraph [0037] of Reference 1 relates to the F# ratio between the wide-angle optical system and the telephoto optical system, and is directed to keep the F# of the two optical systems within a certain range so as to prevent the image from being unnatural because the impression of blurring change greatly during transition.

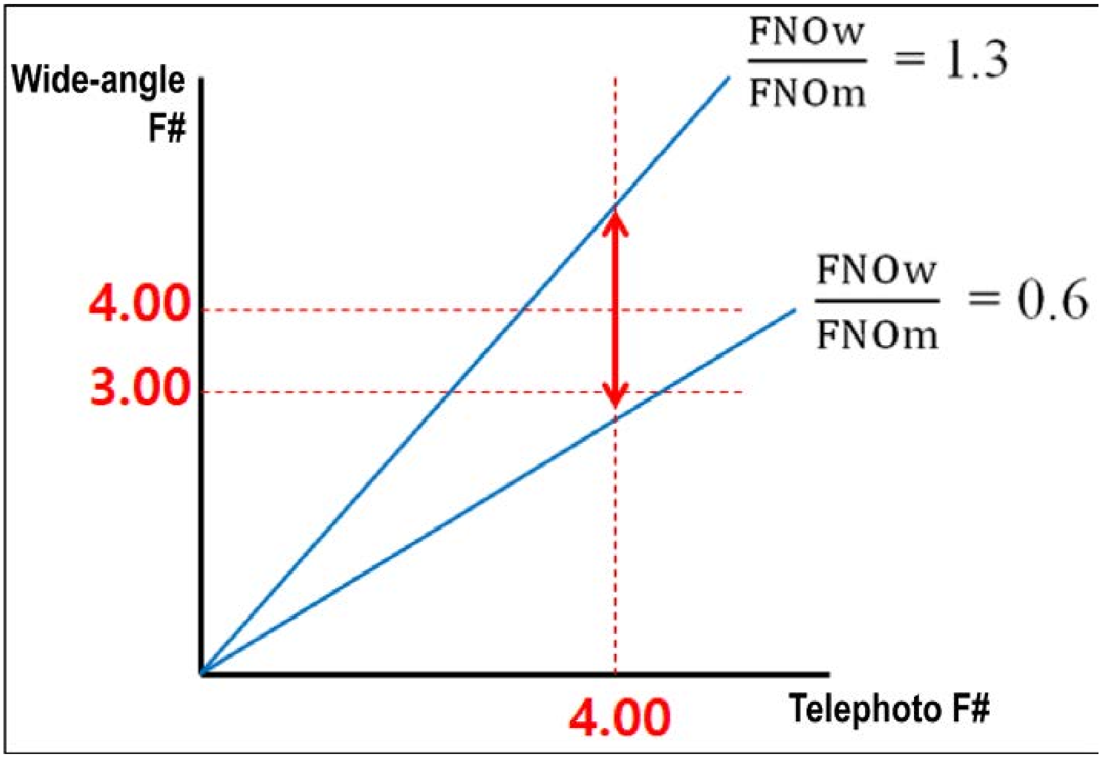
Here, in two embodiments presented by Reference 1, F# of the wide-angle optical system LN1 has different values of 3.00 or 4.00, whereas the F# of the telephoto optical system LN2 is the same value of 4.00. That is, Reference 1 has a motivation to change the F# of the wide-angle optical system in the F# ratio between the two optical systems, but does not suggest a motivation to change the F# of the telephoto optical system (e.g., smaller than 4.00).

Reference 1, rather than trying to change the F# of the telephoto optical system, designed the telephoto optical system's F# to 4.00, and in view of the impression of blurring, just set the wide-angle optical system's F# to 3.00 or 4.00 (see Exhibit No. Eul-4 paragraph [0038]).

> If the F number is significantly different at the time of switching, the impression of blurring will change significantly, which will be unnatural for the user, so F number is preferable to be close in the first, second imaging optical systems in order to satisfy the conditional equation (5). The first imaging optical system

[Exhibit No. Eul-4 paragraph [0038]]

As such, Reference 1 does not provide a motivation to lower the F# of the telephoto optical system, but is for adjusting the F# of the wide-angle optical system based on the F# of the telephoto optical system, 4.00, so that the ratio between the wide-angle optical system and the telephoto optical system is in the range of 0.6 to 1.3.



On the other hand, the effect obtained by setting F# to less than 2.9 in the invention of the subject patent corresponds to a heterogeneous effect that is difficult to predict in Reference 1. In Reference 1, it is difficult to find a motivation to change the F# of the telephoto optical system in order to obtain this effect.

As a result, a person skilled in the art cannot derive 'the configuration in which the F# of the lens assembly is less than 2.9' from Reference 1.

(C) In the corrected subject invention, the inventive step is not denied by the combination of Reference 1 and Prior Art in Exhibit No. Eul-5,6.

In pages 3-18 of the Defendant's Written Submission dated February 8, 2021, after disassembling the components corresponding to the differences 1 to 3 above, the Defendant claims that the disassembled individual components were disclosed in Prior Art of Exhibit No. Eul-5,6, or that such individual components are a commonly used technique.

However, as explained in pages 14-32 of the Petitioner's Written Submission dated June 3, 2021, the Defendant's allegations does not take into account the organic relationship between the components described in the corrected subject invention, and unlike the Defendant's allegations, the lens system for a general camera cannot be combined with the compact telephoto lens system for a portable terminal because the lens systems themselves are different, and the configuration claimed by the Defendant is not a commonly used technique.

	Defendant's allegations			Unjustness of Defendant's claims
	f1<TTL/2	Both-side surface convexity of the first lens element	F#<2.9	
Reference 1	X	X	X	Does not disclose the components
Exhibit No. Eul-5-2	o	o	-	F# significantly exceeds 2.9 Normal large camera telephoto lens other than TTL ≤ 6.5 mm cannot be combined with the subject patent
Exhibit No. Eul-5-3	o	o	-	F# significantly exceeds 2.9 Normal large camera telephoto lens other than TTL ≤ 6.5 mm cannot be combined with the subject patent
Exhibit No. Eul-5-4	o	o	-	F# significantly exceeds 2.9 Normal large camera telephoto lens other than TTL ≤ 6.5 mm cannot be combined with the subject patent
Exhibit No. Eul-6-1	-	-	o	Wide-angle lens other than TTL/EFL < 1 cannot be combined with the subject patent

Exhibit No. Eul-6-2	-	-	o	Not f1<TTL/2 Normal large camera telephoto lens cannot be combined with the subject patent
Exhibit No. Eul-6-3	-	-	o	Not f1<TTL/2 Normal large camera telephoto lens cannot be combined with the subject patent
Exhibit No. Eul-6-4	-	-	o	Wide-angle lens other than TTL/EFL < 1 cannot be combined with the subject patent
Exhibit No. Eul-6-5	-	-	o	Wide-angle lens other than TTL/EFL < 1 cannot be combined with the subject patent

First, the Defendant's allegations, after disassembling the plurality of components described in the claims, only examined whether the disassembled individual components are known, so the Defendant's allegations are in direct opposition to the Supreme Court Reporter regarding the judgment of inventive step.[20]

20

Supreme Court Decision 2006Hu2097 on November 29, 2007
When a claim described in claims of a patented invention consists of a plurality of components, the technical idea as a whole in which each component is organically combined is the subject of the judgment of inventive step, but each component is not independently judged of the inventive step, therefore, in judging the inventive step of the patented invention, after disassembling a plurality of components described in the claims, it should not be examined only whether the disassembled individual components are known, but the difficulty of the composition as an organically combined whole should be examined based on the unique problem-solving principle, wherein the unique effect of the invention as a whole combined composition should also be considered (see Supreme Court Decision 2005Hu3277 on September 6, 2007).

In addition, Exhibit No. Eul-6-1 which was submitted by the Defendant states that the design of the lens system for a general large camera is clearly different from the design of a small lens assembly for a portable terminal,[21] and the lens shape of a general camera is not suitable for that of a portable terminal, so the lens assembly for a portable terminal cannot be based on the lens system for a general camera, but must be redesigned.

Furthermore, it cannot be recognized as a commonly used technique just because it has been disclosed in several prior documents, and it cannot be regarded as a commonly used technique by extracting only some components from the entire lens assembly organically combined.[22]

In the end, the Defendant's allegations are without merit, and the inventive step of the corrected subject invention cannot be denied by Reference 1 alone or by the combination of Reference 1 and the known technology (Exhibit No. Eul-5,6).

H. The filing date of the corrected subject invention is retroactive to the priority date, so Reference 2 cannot be a prior invention of the expanded earlier application.

On pages 19-22 of the Defendant's Written Submission dated February 8, 2021, the Defendant states that the technical description of the specification of the corrected subject invention are not the same as the that of the priority application, so that the filing date cannot be retroactive to the priority date.

However, those of ordinary skill in the art can understand that, in view of the technical common sense at the time of filing, TTL and F# numerical ranges of the invention of the subject patent, and the configuration of “a pair of second and third lens elements having a negative optical power together” are all described in the specification of the priority application, etc.

In the end, since the filing date of the corrected subject invention is retroactive to the priority date, July 4. 2013, Reference 2 with the priority date of October 31, 2013 cannot be a prior invention of the expanded earlier application.

[21] See pages 17-22, Plantiff’s Written Submission dated June 3, 2021

[22] See pages 23-33, Plantiff’s Written Submission dated June 3, 2021

4. Conclusion

As described above, the Defendant's allegations are without merit, and the corrected subject invention has no reason for invalidation. Therefore, please cancel the trial decision in this case.

References

1. Reference 1 Science Encyclopedia, search result screen for “response function”

1. Reference 2 Specifications for OPPO X907

1. Reference 3 Specifications for Fujitsu Arrows ES IS12F

1. Reference 4 Specifications for Huawei Ascend Pls

1. Reference 5 Specifications for Apple iPhone 5

1. Reference 6 Manual for Samsung Galaxy S4

1. Reference 7 Specifications for SONY Xperia Z Ultra

1. Reference 8 Samsung Homepage Folded Lens Screen

Attached documents

1. 1 copy of each of the above reference materials

August 2, 2021

Paintiff's attorney

YULCHON Attorneys at Law

Attorney Choi Jeong-yeol

Attorney Jeong Sang-tae

Attorney Lee Han-Gyeol

Attorney Kim Ha-young

C&S PATENT AND LAW OFFICE

Patent Attorney Son Won

Patent Attorney Hwang Woo-Taek

Patent Attorney Lee Eui-Hoon

Patent Attorney Yoon Byung-Hoon

Patent Attorney Ahn Seong-su

Patent Attorney Kwak In-Young

(To) Patent Court 3rd Div.

참 고 서 면

사	건	**2020허6323 등록무효(특)**
원	고	코어포토닉스 리미티드
피	고	엘지이노텍 주식회사

위 사건에 관하여 **원고 소송대리인**은 피고의 2021. 2. 8.자, 2021. 5. 28.자 준비서면에 대하여 다음과 같이 반박하면서 참고서면을 제출합니다.

다 음

1. 피고 주장의 요지 및 그 부당성

피고는 2021. 5. 28.자 준비서면에서 이 사건 정정발명은 ① 명세서의 뒷받침 기재 요건 및 용이실시 기재 요건이 결여되어 있고, ② 청구항의 명확, 간결한 기재 요건이 결여되어 있으며, ③ 신규사항 추가의 무효사유가 있다고 주장하고 있습니다.

또한 피고는 2021. 2. 8. 자 준비서면에서 이 사건 정정발명은 ④ 선행발명 1 단독에 의하여 또는 선행발명 1과 주지관용기술(또는 을 제5, 6호증의 선행기술)과의 결합에 의하여 진보성이 부정되고, ⑤ 이 사건 정정발명은 출원일이 우선일로 소급되지 않으므로, 선행발명 2와 동일하여 확대된 선출원 위반의 무효사유가 있다는 주장을 반복하고 있습니다.

그러나 피고의 주장은 모두 이유 없습니다.

이하에서는 먼저 재판부께서 2021. 6. 10.자 변론기일에서 질의하신 사항에 대하여 보충 설명드린 후 피고 주장의 부당성에 대하여 구체적으로 말씀 드리겠습니다.

2. 2021. 6. 10.자 변론기일 재판부 질의사항에 대한 보충 설명

가. 이 사건 특허발명 출원 당시의 휴대 단말기에 적용된 카메라 현황

이 사건 특허발명은 휴대 단말기에 장착되는 망원 렌즈 조립체에 관한 원천기술이고 현재까지 널리 사용되고 있습니다.

이 사건 특허발명 출원 당시(2013년경) 휴대 단말기에 망원 렌즈 조립체를 장착하는 선행문헌은 1건에 불과하였고,[1] 휴대 단말기용 카메라 제조업체 대부분은 '망원 렌즈 조립체'가 아닌 '광각 렌즈 조립체'를 개발하려고 노력하고 있었습니다.[2]

이 사건 특허의 명세서 단락 [0004], [0005]는 종래기술로 4개의 렌즈 요소들을 포함하는 렌즈 조립체는 소형의 이미지 촬영 렌즈 시스템으로서 양호한 품질의 이미지를 얻기에 충분하지 않았고 5개의 렌즈 요소들을 사용한 (광각 렌즈 조립체인) US 제8,395,851호는 TTL 및 EFL 사이의 비율이 큰 문제점이 있다고 기재하고 있습니다. 이는 이 사건 특허발명 출원 당시 휴대 단말기에 적용되는 망원 렌즈 조립체가 거의 없었기 때문입니다.

등록특허 10-1757101

요는 성장을 계속하고 있다. 특히, 휴대 장치 내에서 카메라는 양질의 이미지 촬영을 위한, 그리고 작은 총 트랙 길이(TTL)를 갖는 소형의 이미지 촬영 렌즈 시스템을 필요로 한다. 4개의 렌즈 요소들을 포함하는 종래의 렌즈 조립체는, 더 이상 이러한 장치 내에서 양호한 품질의 이미지를 얻기에 충분하지 않다. 최신의 렌즈 조립체 설계는, 예를 들면 US 제8,395,851호에서는, 5개의 렌즈 요소들을 사용한다. 그러나, US 제8,395,851호에서의 설계는, TTL 및 유효 초점 길이(EFL) 사이의 비율이 너무 크다는 사실로부터 적어도 문제점을 갖는다.

[0005] 그러므로, 당 업계에서는, 기존의 렌즈 조립체보다 작은 TTL/EFL 비율을 제공하고, 그리고 더 나은 이미지 품질을 제공할 수 있는 5개의 렌즈 요소의 광학 렌즈 조립체를 위한 필요성이 존재한다.

[이 사건 특허명세서 중 해당 부분 발췌]

---

[1] 피고가 제출한 자료 중 이 사건 특허발명의 우선일 전에 공개된 휴대 단말기용 소형 망원 렌즈 조립체는 선행발명 1(을 제4호증) 하나에 불과합니다. 원고가 파악하고 있는 현황도 별반 다르지 않습니다.

[2] 휴대 단말기에 광각 카메라가 적용된 시기는 1990년대 후반이고, 휴대 단말기용 망원 카메라가 실제로 적용된 시기는 2017년 하반기입니다. 이와 같이 휴대 단말기에 망원 카메라가 적용되기까지 약 20 년이 소요되었다는 사실은 이 사건 특허발명의 기술적 우수성을 잘 보여줍니다.

휴대 단말기에 적용되는 망원 렌즈 조립체가 짧은 총 트랙길이(TTL)라는 제약된 환경 하에서 충분한 이미지 품질을 얻기 위해서는 종래의 일반 카메라용 망원 렌즈 조립체와는 다른 새로운 구조와 형태가 필요하였습니다.[3] 이를 위해 이 사건 특허발명은 ① 짧은 총 트랙길이를 가지고(TTL≤6.5mm), ② 총 트랙길이보다 긴 초점거리(EFL)를 가지며, ③ 제1 렌즈요소의 굴절력을 크게(f1<TTL/2)하고, ④ F#를 2.9 미만으로 하는 새로운 구성을 채택하였습니다(2020.11.25자 원고 준비서면 2면 이하 참고).

나. TTL의 상한, F#의 상한 및 제1렌즈요소의 양의 굴절력과 TTL의 관계에 관하여

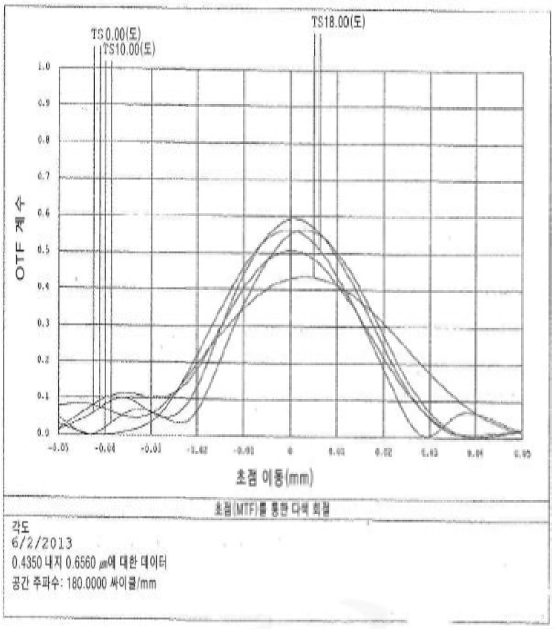
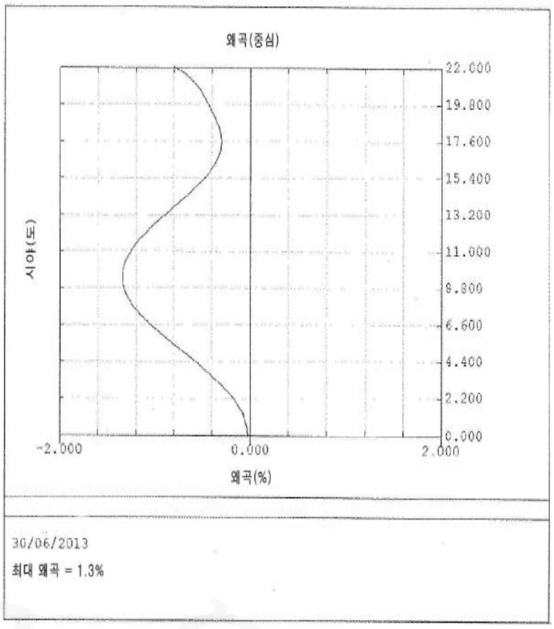
TTL < 6.5mm, TTL/EFL ≤ 1, F# < 2.9, f1 < TTL/2 구성과 관련하여, ① TTL의 상한 6.5mm(TTL < 6.5mm 구성 관련)는 휴대용 단말기의 두께에 따른 렌즈 조립체의 한계와 관련되고, ② F#의 상한 2.9는 렌즈 조립체의 최대 입사 광량과 관련되며, ③ 제1 렌즈요소의 양의 굴절력이 커질수록 TTL이 줄어드는 상관관계가 있습니다.

그런데 진보성 판단에 있어 위 각 구성이 선행발명에 개별적으로 개시되었는지 여부를 고려하여서는 안되고, 위 각 구성이 유기적으로 결합된 발명 전체를 기준으로 진보성 여부를 판단하여야 합니다.

이 사건 제1항 정정발명은 TTL < 6.5mm, TTL/EFL ≤ 1, F# < 2.9, f1 < TTL/2 등의 구성이 **유기적으로 결합됨으로써** 휴대 단말기용 소형 망원 렌즈 조립체에서 높은 이미지 화질을 얻을 수 있고, 상기 얻어진 이미지의 왜곡 오차가 인간의 눈으로는 인식 불가능한 2% 이내인 양질의 이미지를 얻을 수 있는 것입니다. 이는 이 사건 특허 도면 1b, 1c 및 도면 2b, 2c, 도면 3b, 3c 등에서도 확인됩니다. 대표적으로 도면 1b, 1c는 아래와 같습니다.

(도면 1b)	(도면 1c)

[3] 통상의 일반 카메라용 망원 렌즈 조립체를 그대로 축소할 경우, 필름에 해당하는 촬상 소자의 면적이 극히 좁아져서 양호한 이미지를 얻을 수 없습니다(2021.05.25. 자 원고 준비서면 19-20면 참고). 이는 피고가 제출한 을 제6호증의1에도 명확하게 기재되어 있습니다.

	
센서의 각 부분 별로, 초점 위치(0mm) 근처에서 최대의 OTF계수값[4]을 가지므로, 이미지가 선명함	이미지 왜곡이 사람의 시각이 인지할 수 있는 2% 보다 작은 최대 1.5%를 나타냄

다. 통상의 기술자는 현재 'TTL의 하한'을 어느 정도로 보는지에 관하여

아래 표와 같이 이 사건 특허발명의 우선일(2013.07.04.) 당시 휴대 단말기 두께의 하한은 6.5㎜ 이상이었습니다. 휴대 단말기의 작동을 위한 부품 기술 발전 및 광각과 망원 렌즈 조립체에 장착되는 렌즈 개수 등을 고려하면, 현재 휴대 단말기의 두께(또는 TTL의 최대 하한)은 4.5㎜~5㎜로 예상됩니다.

[이 사건 특허발명의 우선일 당시 휴대 단말기 제조사별 휴대 단말기의 두께 정리표]

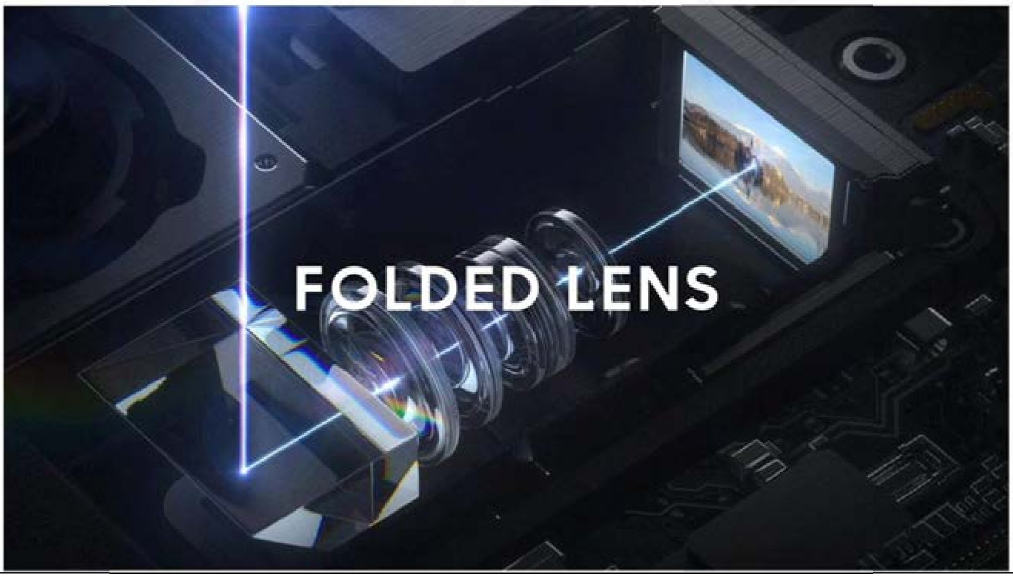
[4] OTF는 optical transfer function의 약자로 렌즈 등의 광학계가 가진 공간 주파수 전송능력을 나타내는 함수로서 해상력을 표시하는 방법을 말합니다(참고자료 1. 과학백과사전 레스폰스함수 검색화면)

제조사	모델명	공개일	스마트폰 두께	비고
OPPO	X907	2012.06	6.65 mm	참고자료 2
후지쯔	Arrows ES IS12F	2012.01	6.7 mm	참고자료 3
화웨이	Ascend P1s	2012.01	6.68 mm	참고자료 4
애플	아이폰 5	2012.09	7.6 mm	참고자료 5
삼성전자	갤럭시 S4	2013.03	7.9 mm	참고자료 6
SONY	엑스페리아 Z 울트라	2013.06	6.5 mm	참고자료 7

최근에는 렌즈의 배치 방향을 휴대 단말기의 두께 방향에서 폭 방향으로 직각으로 꺾어 배치하는 방식이나, 카메라 수를 증가시키는 방식을 채택하여 휴대 단말기 두께로 인한 한계를 극복하는 기술이 개발되고 있습니다.

참고자료 8. 삼성홈페이지 폴디드 렌즈 화면

렌즈의 경우 수직 구조로 공간을 더 필요로 하기 때문에 카메라가 두꺼워지지만, 폴디드 렌즈는 잠망경 원리와 같이 프리즘을 사용한 방식이기 때문에 스마트폰 카메라 바닥에 평평하게 자리 잡을 수 있었던 것. 스마트폰 뒷면을 통해 들어오는 빛이 프리즘에 의해 렌즈로 전달되면, 폰 내부에 렌즈의 구조를 가로로 정렬한 폴디드 렌즈가 이를 다시 90도로 굴절 시켜 초점 거리를 늘린다. 이렇게 카메라의 높이와 넓이가 줄어들어 갤럭시 S20 울트라의 혁신적인 줌 성능이 구현된다.



현재 통상의 기술자가 예상하는 휴대 단말기의 두께(TTL의 하한으로서 4.5㎜~5㎜)를 고려해볼 때 "이 사건 특허의 상세한 설명은 TTL이 0에 근접한 값(0.1mm 이하) 및 F#가 0에 근접한 값(10^{-3} 이하)을 쉽게 실시할 수 있을 정도로 기재되어 있지 않다"

는 이 사건 심결의 판단(또는 채권자 주장)은 이 사건 특허발명의 기술적 의의를 잠식시키는 극단적인 경우들을 상정한 것으로서 전혀 타당하지 않습니다.[5]

라. 이 사건 제1항 정정발명의 TTL의 상한 6.5㎜ 와 F#의 상한 2.9 구성은 어떻게 정해진 수치인지에 관하여

<u>휴대 단말기에 장착되는 소형 망원 렌즈 조립체는</u> 어느 두께(TTL의 길이)의 소형 휴대 단말기에 장착되는지 여부가 매우 중요한 고려사항이고, 이는 TTL의 길이의 별다른 제한이 없는 일반 렌즈 조립체와 다릅니다. 또한 소형 망원 렌즈 조립체는 고화질의 구현을 위한 많은 광량을 제공할 수 있는지 여부가 중요한 고려사항인데 이는 종래의 짧은 초점거리를 갖는 광각 렌즈 조립체에서는 광량 부족이 발생하지 않아 별 문제가 안되는 사항입니다. 즉 소형의 휴대 단말기에 장착되는 망원 렌즈 조립체에서는 TTL과 F#의 수치는 그 상한에 그 기술적 의의가 있습니다.

이 사건 특허발명 출원 당시(2013년경)에는 휴대 단말기에 망원 렌즈 조립체를 장착하는 기술은 거의 없었고, 이 사건 특허발명의 발명자들은 소형의 휴대 단말기에 장착하여 양질의 이미지를 얻을 수 있는 소형 망원 렌즈 조립체를 연구한 결과 최적의 TTL의 상한 및 F#의 상한을 도출한 것입니다.

TTL의 수치범위는 이 사건 특허의 상세한 설명의 'TTL은 EFL보다 작[다]'는 기재[6]와 실시예의 TTL값을 통해 도출할 수 있습니다.

즉 TTL < EFL 및 EFL = 6.90mm(실시예 1), 7mm(실시예 2), 6.84mm(실시예 3) 등의 실시예에서 적어도 TTL < 7mm 에서 충분히 양질의 이미지를 얻을 수 있었습니다. 또한 실시예에서는 이보다 더 얇은 TTL= 5.904mm(실시예 1), 5.90mm(실시예 2), 5.904mm(실시예 3)에서도 양호한 이미지를 얻을 수 있음을 확인한 후, <u>다른 구성요소들과 유기</u>

---

[5] 특허법원 2018. 8. 30. 선고 2018허2700 판결은 "이 사건 특허발명의 기술적 의의를 잠식시키는 극단적인 경우들을 상정하여 그 실시까지 가능하도록 발명의 설명에 기재되어 있을 것을 요구할 수도 없다"고 판시하였습니다.

[6] 갑 제3호증 단락 [0009]

적으로 결합하는 경우에도 충분히 양호한 이미지를 얻을 수 있도록 'TTL의 상한을 7mm보다 작은 6.5mm로 줄여 한정한 것입니다.[7]

F#와 관련해서는, F# < 2.9 조건은 '렌즈 조립체는 F 번호, F# < 3.2를 갖는다'는 기재(갑 제3호증 단락 [0009]) 및 (TTL이 6.5mm 이하이고 TTL/EFL이 1보다 작은 휴대 단말기의 소형 망원 렌즈 조립체에서 양호한 이미지 품질을 얻을 수 있는 충분한 광량을 얻기 위한 실시예로서) F#= 2.80(실시예 1), 2.86(실시예 2), 2.80(실시예 3)을 통해 도출된 것입니다. 한편 휴대 단말기에 사용되는 이미지 센서는 크기에 제한이 있으므로 제한된 면적 조건 하에서 해상도를 향상시키기 위해 이미지 센서의 화소수를 늘리는 경우에도[8] 충분한 광량을 확보할 수 있도록 F#의 상한을 3.2보다 작은 2.9로 한정한 것입니다.

마. 렌즈 분야의 기술 상식에 비추어 TTL을 더 작게 하는 것과 F#를 더 작게 하는 것이 기술과제인지 여부

휴대 단말기용 망원 렌즈 조립체는 일반 망원 카메라와 그 기술사상에 있어서 많은 차이가 있었기 때문에, 이 사건 특허발명 출원 당시에는 통상의 기술자는 휴대 단말기에 망원 렌즈 조립체를 설치할 수 있다는 생각을 하지 못하였습니다. 따라서 당시 통상의 기술자는 휴대 단말기용 망원 렌즈 조립체를 개발하기 위한 기술적 과제로서 '작은 TTL을 가지면서 TTL을 EFL보다 더 작게 하고 동시에 F#를 작게 하는 기술적 과제'를 전혀 인식하지도 못하였습니다.

통상의 기술자는 이 사건 특허발명 출원 당시 '휴대 단말기에 설치할 수 있는 작은 TTL을 가지면서, TTL을 EFL보다 더 작게 하고 F#를 작게 한' 휴대 단말기의 망원 렌즈 조립체가 이 사건 특허발명의 도면 1b, c 및 도면 2b, c, 도면 3b, c와 같은 양호

[7] 이는 이 사건 특허발명이 휴대단말기 등에 사용된다는 의미함과 동시에, **일반적인 망원 카메라와 달리** 두께가 매우 얇은, 즉 이 사건 특허발명의 우선일 당시 휴대 단말기의 두께(6.5㎜ 이상)에 충분히 장착할 수 있는 망원 렌즈 조립체임을 나타내는 것입니다.

[8] 개별 화소의 크기는 작아지게 됩니다.

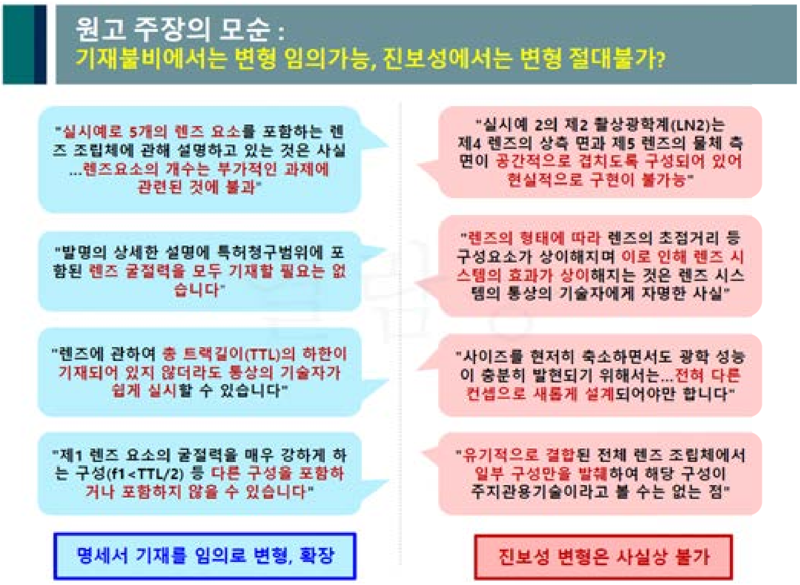
한 이미지를 얻을 수 있는 것도 예측할 수 없었습니다.

휴대 단말기용 망원 렌즈 조립체가 일반화된 현재를 기준으로 '휴대 단말기에 설치할 수 있는 작은 TTL을 가지면서, TTL을 EFL보다 더 작게 하고 F#를 더 작게 하는 것'이 이 분야의 일반적인 기술 과제라고 본다면 이는 통상의 기술자가 이 사건 특허의 명세서에 개시된 기술을 알고 있음을 전제로 사후적으로 판단한 것으로 전형적인 사후적 고찰입니다.

3. 피고 주장에 대한 반박

가. 기재불비와 진보성 부분에 대한 원고 주장에는 아무런 모순이 없습니다.

피고는, 원고 주장은 진보성 부분에서는 통상의 기술자가 렌즈 조립체의 구성을 임의로 변경할 수 없는 반면 기재불비 부분에서는 렌즈 조립체의 구성을 임의로 변경할 수 있다는 것으로 서로 모순된다고 주장합니다(2021. 6. 10.자 피고 변론자료 70면).



[2021. 6. 10.자 피고 변론자료 70면]

그러나 피고 주장은 전혀 이유 없습니다.

용이 실시 가능성(기재불비 관련)은 통상의 기술자가 **특허발명의 명세서의 기재와 출원 당시의 기술수준**을 참고하여 청구항에 기재된 발명을 쉽게 실시할 수 있는지 여부를 판단하는 것입니다. 따라서 통상의 기술자라면 출원 당시의 기술수준과 이 사건 특허의 명세서의 기재를 참고하여 이 사건 특허발명이 제안하는 핵심구성을 바탕으로 나머지 렌즈 구성을 변경하는 것은 기술적으로 어렵지 않습니다.

반면 **구성의 곤란성 여부(진보성 관련)는** 통상의 기술자가 이 사건 특허발명의 구성을 알지 못하는 상태에서 출원 당시의 **선행발명으로부터** 특허발명의 구성을 도출하는 것이 쉬운지 여부를 판단하는 것입니다. 그런데 이 사건 특허발명과 선행발명들은 그 기술사상에 있어서 근본적인 차이가 있고 구체적인 구성도 다르기 때문에 통상의 기술자가 선행발명들로부터 (또는 선행발명의 구성을 변경하여) 이 사건 특허발명의 구성의 전부 또는 일부를 도출할 수 없습니다.

따라서 원고 주장은 전혀 모순되지 않습니다.

나. 이 사건 특허발명은 발명의 상세한 설명에 의하여 뒷받침되지 않는다는 피고의 주장은 이유 없습니다.

(1) 피고는 이 사건 특허의 상세한 설명에 5개 렌즈 요소의 굴절력 조합(양/음/음/양/음)을 특정하여 기재하고 있으므로, 이와 다른 조합의 렌즈 조립체의 구성은 발명의 상세한 설명에 뒷받침되지 않는다고 주장합니다(2021. 5. 28.자 피고 준비서면 3 내지 5면).

그러나 위 피고 주장도 모두 이유 없습니다.

(2) 렌즈 매수와 관련하여, 이 사건 특허발명의 기술적 과제는 5개 렌즈 요소의 굴절력 조합으로 한정된 것이 아니라, 두께가 얇으면서도 양호한 이미지를 얻을 수 있는 (더 작은 TTL/EFL 비율을 갖는) 휴대 단말기용 소형 망원 렌즈 조립체를 제공하는 것입니다(자세한 내용은 2021. 2. 18.자 원고 준비서면 3 내지 17면 참고)

이 사건 특허의 상세한 설명은 4개의 렌즈요소를 초과하는 경우에도 두께가 얇으

면서 양호한 이미지를 얻을 수 있는 소형 망원 렌즈 조립체가 필요하다고 기재하고 있으며(갑 제3호증 단락 [0004], [0005]), 반드시 5개의 렌즈요소의 광학렌즈 조립체로 한정하고 있지 않습니다.

또한 이 사건 특허발명은 '해결하려는 과제'로 종래의 문제점을 해결할 수 있는 소형 망원 렌즈 조립체를 제공함에 그 목적이 있다고 기재할 뿐, 렌즈 요소의 개수를 한정하고 있지 않습니다(갑 제3호증 단락 [0006]).

나아가 이 사건 특허발명은 '실시예'로서 개방형 청구항 형식인 '제5 렌즈요소들을 포함'하는 광학렌즈 조립체를 기재하고 있으므로(갑 제3호증 단락 [0007]) 렌즈요소를 5개로 한정하는 것이 아닙니다.

한편 피고 주장은 발명의 상세한 설명에 실시예로 기재된 렌즈 조립체의 모든 구성을 독립항에 기재해야 한다는 것인데, 이는 발명을 독립항과 종속항으로 나누어 기재할 수 있다고 규정하고 있는 특허법 규정[9] 및 '특허청구범위에 기재된 구성이 반드시 발명의 상세한 설명이나 도면에 기재되어 있어야 하는 것은 아니다'라고 판시한 대법원 판결(대법원 2006. 11. 24. 선고 2003후2072 판결[10])에 반합니다.

피고 자신도 발명의 상세한 설명에 일 실시예로 기재된 발명을 특허청구범위에 세분화하여 기재한 특허를 다수 등록 받은 바 있습니다.[11]

(3) 굴절력 조합과 관련하여, 이 사건 특허발명의 출원 당시의 기술 수준 및 이 사건 특허명세서의 기재들을 고려해보면, 이 사건 제35항 발명의 '음의 광학력을 함께 갖는 한 쌍의 제2 및 제3 렌즈 요소들'에 대응되는 사항은 이 사건 특허의 상

[9] 특허법 시행령 제5호제1항

[10] "이 사건 특허발명이 모두 청구항에 명시적으로 기재된 구성요소 외에 다른 기술들을 추가하여 실시할 수 있는 기재형식을 취하고 있는 이상, 이 사건 제17항 내지 제22항 발명의 실시예에 관한 상세한 설명이나 도면이 청구항에는 기재되어 있지 아니한 '단어와 조사를 분리하는 단계'를 추가하여 보여주고 있다고 하더라도 그러한 사정만으로 위 제17항 내지 제22항 발명이 상세한 설명에 의하여 뒷받침되지 않는다고 할 수 없을 것이다."

[11] 갑 제10호증 및 제11호증 각 등록특허공보 및 2021.02.18. 자 원고의 준비서면 4 내지 6면 참조

세한 설명 및 도면에 기재되어 있거나 통상의 기술자가 이 사건 명세서 기재로부터 충분히 인식 가능합니다(2021. 2. 18.자 원고 준비서면 9 내지 10면).

구체적으로, 이 사건 특허의 상세한 설명에는 "제3 및 제4 렌즈요소들 사이의 비교적 긴 거리와 제4 및 제5 렌즈요소들의 조합된 설계는 이미지 면에 모든 시야의 초점들을 가져오는 데에 도움을 준다"는 기재(갑 제3호증 단락 [0011]), "양의 굴절력을 갖는 제1 렌즈요소의 초점 길이 f1 이 TTL/2 보다 작다"는 기재(갑 제3호증 단락 [0009])가 있습니다.

이는 양의 굴절력(즉, 수렴렌즈)을 갖는 제1 렌즈요소를 통과하면서 한 점으로 강하게 집광되도록 굴절된 광은 제2 렌즈요소와 제3 렌즈요소를 통과한 뒤에 상대적으로 긴 거리를 지나(즉, 제3 및 제4 렌즈요소들 사이의 긴 거리) 제4 렌즈요소를 통과해야 함을 의미합니다.

즉 빛이 제3 및 제4 렌즈요소들 사이의 긴 거리를 지나 제4 렌즈요소에 도달하기 위해서는 **제2 렌즈요소와 제3 렌즈요소는 빛을 퍼뜨려 주는 오목 렌즈(음의 굴절력)의 기능을 필수적으로 수행해야 함**을 통상의 기술자라면 누구나 쉽게 파악할 수 있습니다.

또한 제2 렌즈요소의 f2, 제3 렌즈요소의 f3이 각각 양의 값 또는 음의 값을 가질 수 있다는 것은 이 사건 특허의 상세한 설명에서 '최소 색수차는 조건 1.2x｜f3｜>｜f2｜>1.5xf1 을 충족함으로써 얻어'진다고 하여 절대값으로 표기하고 있는 기재와도 정확하게 일치합니다(갑 제3호증 단락 [0010]).

다. 특허청구범위에 TTL과 F# 값의 하한이 기재되어 있지 않아도 통상의 기술자는 이 사건 정정발명을 실시할 수 있습니다.

피고는 수치범위의 상한 또는 하한을 설정하지 않을 경우, 통상의 기술자가 청구범위에 기재된 발명을 쉽게 실시할 수 없다고 주장합니다(2021. 5. 28.자 피고 준비서면 7 내지 10면).

그러나 위 피고 주장도 이유 없습니다.

우선 본건 통상의 기술자는 '렌즈 조립체 기술 분야의 석사과정을 마치고, 2~3년 정도의 업계 경력을 가진 자'로 상정할 수 있습니다.

그런데 통상의 기술자가 TTL 또는 F# 의 하한이 기재되어 있지 않다고 하여 관련 렌즈 조립체 발명을 실시할 수 없다는 피고 주장은 억지스러운 주장입니다.

앞서 설명드린 바와 같이 이 사건 특허발명의 기술적인 의의는 TTL 및 F#의 상한에 있는 것이고, TTL의 하한, F#의 하한 등은 휴대 단말기의 두께나 광량 등의 물리적 한계가 있어 통상의 기술자가 필요에 따라 쉽게 설정할 수 있습니다.

따라서 기술적으로 중요한 수치의 상한이 기재되어 있는 이상 통상의 기술자는 이 사건 특허발명을 당연히 실시할 수 있습니다.[12]

유사 사례로서 세계 각국 특허청은 청구범위에 TTL이나 F# 의 하한의 구성을 기재하지 않은 경우도 실시 가능한 것으로 보고 있습니다(갑 제9호증, 제28호증 내지 제34호증).

만일 피고 주장대로 실시 가능한 모든 수치범위를 기재하여야 한다면, 발명자는 의미 없는 수치 하한을 찾기 위해 불필요한 실험을 다수 수행하여야 하는 부당한 결론에 이르게 됩니다.[13]

라. 이 사건 특허발명의 TTL 또는 F# 수치범위는 발명의 상세한 설명에 의해 뒷받침됩니다.

피고는 이 사건 특허발명에 TTL의 수치범위(TTL ≤ 6.5mm)와 F# 수치범위(F#<2.9)

[12] 특허법원 2013. 1. 25. 선고 2012허6700 판결도 기술적으로 중요한 수치의 상한 또는 하한만을 특정하면 충분한 것이고, 기술적으로 중요하지 않은 하한 또는 상한이 특정되지 않았다고 해서 발명이 불명확하다고 볼 수는 없다고 판시하였습니다.

[13] 실제로 그러한 (의미 없는) 수치의 하한에서 임계적 의의가 있는 것인지 여부도 확인이 불가능할 수 있습니다.

의 각 하한이 기재되어 있지 않아 뒷받침 요건 결여의 기재불비 사유가 있다고 주장합니다(2021. 5. 28.자 피고 준비서면 6면).

그러나 위 피고 주장 역시 이유없습니다.

대법원은 "청구항이 발명의 상세한 설명에 의하여 뒷받침 되는지는 통상의 기술자의 입장에서 특허청구범위에 기재된 사항과 대응되는 사항이 발명의 상세한 설명에 기재되어 있는지 여부에 의하여 판단하여야 한다"고 일관되게 판시하고 있습니다(대법원 2014. 9. 4. 선고 2012후832 판결).

그런데 휴대 단말기용 렌즈 시스템을 설계하는 통상의 기술자는 TTL의 상한으로부터 이 사건 특허발명이 두께가 매우 얇은 소형의 휴대 단말기 등에 적용되는 것임을 바로 인식할 것이고, F#의 상한 또한 휴대 단말기용 소형 망원 렌즈 조립체에서 양호한 이미지 품질을 얻기 위한 충분한 광량을 요구한다는 의미를 쉽게 파악할 수 있습니다.

구체적으로 2021. 2.18.자 원고의 준비서면 26면 및 이 참고서면 6 내지 7면 2. 라.에서 설명드린 바와 같이 'TTL≤6.5mm' 구성은 이 사건 특허의 상세한 설명의 'TTL은 EFL보다 작[다]'는 기재(갑 제3호증 단락 [0009]), 각 실시예의 EFL값(6.90mm, 7mm, 6.84mm), 각 실시예의 TTL값(5.904mm, 5.90mm, 5.904mm)을 통해 도출된 것입니다. 따라서 이 사건 정정발명 청구범위는 발명의 상세한 설명의 범위 내에서 한정한 것으로서, 발명의 상세한 설명에 대응되는 구성이 기재되어 있으므로 발명의 상세한 설명에 의하여 충분히 뒷받침되는 구성에 해당합니다.

나아가 F#의 수치범위에 대하여도, '렌즈 조립체의 F#는 2.9보다 작은 구성'은 이 사건 특허발명의 과제 해결 수단의 '렌즈 조립체는 F 번호, F# < 3.2를 갖는다'는 기재(갑 제3호증 단락 [0009]) 및 각 실시예의 F#값(2.80, 2.86, 2.80)을 통해 도출된 것입니다. 위 구성은 이 사건 특허의 상세한 설명에 기재된 수치범위 내에서 고화질의 구현을 위한 많은 광량을 충분히 제공할 수 있도록 그 수치범위를 좁게 한정한 것이므로, 문언적으로도 발명의 상세한 설명에 뒷받침됩니다.

또한 특허청구범위에 청구항으로 기재된 사항은 발명의 설명에 개시한 발명 중 출원인이 스스로의 의사로 특허권으로 보호받고자 하는 사항으로 선택하여 기재한 사항이라고 규정한 특허청 심사기준[14]이나, 특허청구범위에 어떠한 구성요소를 기재할지 여부는 출원인이 자유롭게 결정할 수 있다는 판결[15]에 비추어 보더라도, 이 사건 특허의 상세한 설명에 기재된 수치범위 내에서 선택된 이 사건 특허발명의 청구범위는 발명의 상세한 설명에 뒷받침됩니다.

특허·실용신안 심사기준은 청구범위가 발명의 상세한 설명에 의해 뒷받침되는지 여부에 대하여 해당 기술분야에서 통상의 지식을 가진 자가 발명의 설명으로부터 파악할 수 있는 범위를 벗어난 발명을 청구항에서 청구하고 있는 것은 아닌지를 중점적으로 검토하여 판단한다고 기재하고 있습니다.

갑 제35호증 특허 실용신안 심사기준(개정 2020. 12. 14. 특허청 예규 제117호)

14

갑제 35호증 하단 페이지 기준 2402면 '2. 발명의 인정' 부분 참조
청구범위에 청구항으로 기재된 사항은 특허법 제42조제4항 및 제8항의 청구범위 기재방법에 따라 발명의 설명에 개시한 발명 중 <u>출원인이 스스로의 의사로 특허권으로 보호를 받고자 하는 사항으로 선택하여 기재한 사항</u>이다.

15

특허법원 2009. 12. 24 선고 2009허4742 판결
특허발명의 청구항에 '발명의구성에 없어서는 아니 되는 사항만으로 기재될 것'을 요구하는 구 특허법 제42조 제4항제3호는 출원발명에 대한 특허 후에 그 특허청구범위에 발명의 구성에 필요한 구성요소를 모두 기재하지 아니하였음을 들어 특허 당시 기재되어 있지 아니하였던 구성요소를 가지고 원래 기재되어 있던 듯이 포함하여 해석하여야 한다고 주장할 수 없음은 물론, 청구항에 기재된 구성요소는 모두 필수구성요소로 파악되어야 하며 일부 구성요소를 그 중요성이 떨어진다는 등의 이유로 필수구성요소가 아니라고 주장할 수 없다는 것을 확인하는 것으로 보아야 할 뿐(대법원 2006. 11. 24. 선고 2003후2072 판결 참조), <u>그 특허발명의 목적과 효과 달성에 필요한 모든 구성을 특허청구범위에 기재할 것을 요구하는 규정으로 볼 수 없고, 특허청구범위에 어떠한 구성요소를 기재할 지 여부는 출원인이 그 발명의 기술적 범위를 좁게 할 것인지, 넓게 할 것인지 등을 고려하여 자유롭게 결정할 수 있다고 할 것</u>이며, 특허발명의 목적과 효과 달성에 필요한 것으로 보이는 구성요소 일부를 특허청구범위에 기재하지 아니한 경우 그로 인하여 미완성 발명이 되거나 진보성을 결여하는 등의 이유로 특허등록을 받을 수 없는 것은 별론으로 하고, 이를 들어 구 특허법 제42조 제4항제3호에 위반되어 특허등록을 받을 수 없다고 할 수는 없다.

대응되는 사항이 발명의 설명에 기재되어 있는지는, 청구항과 발명의 설명의 문언상 동일 여부보다는 제42조제4항제1호의 취지를 고려하여 해당 기술분야에서 통상의 지식을 가진 자가 발명의 설명으로부터 파악할 수 있는 범위를 벗어난 발명을 청구항에서 청구하고 있는 것은 아닌지를 중점적으로 검토하여 판단한다.

나아가 특허법원은 "특허발명의 명세서에 특허청구범위를 뒷받침하는 모든 실시예를 기재하여야 하는 것은 아니므로 사방확정 관련 실시예가 기재되어 있지 않다 하더라도 이를 이유로 기재불비라 할 수는 없다"고 판시하였습니다(특허법원 2011. 8. 10. 선고 2011허620 판결).

따라서 이 사건 특허발명의 TTL 또는 F# 수치범위는 발명의 상세한 설명에 충분히 뒷받침되고 이에 반하는 피고 주장은 이유 없습니다.

마. 이 사건 특허발명의 TTL 또는 F# 수치범위는 청구범위에 명확하고 간결하게 기재되어 있습니다.

피고는 TTL 또는 F# 수치범위는 하한이 없으므로, 특허청구범위가 명확하고 간결하게 기재되어 있지 않다고 주장합니다(2021. 5. 28.자 피고 준비서면 10, 11면).

그러나 이 사건 특허발명은 수치범위의 하한이 기재되어 있지 않다는 이유로 이 사건 특허발명에 기재불비의 무효사유가 있다고 볼 수 없습니다.

앞에서 설명 드린 바와 같이, 이 사건 특허발명은 TTL 및 F#의 상한에 기술적 따라서 통상의 기술자는 이 사건 특허발명에 TTL 및 F#의 하한의 기재가 없더라도 TTL 및 F#의 상한값으로 이 사건 특허발명을 명확하게 파악할 수 있습니다.

더욱이 이 사건 특허발명은 TTL과 F#의 상한을 한정하여 오히려 이 사건 특허발명의 권리범위를 TTL과 F#에 대하여 더욱더 좁은 범위로 한정한 것으로서, 이러한 수치범위로 인해 종래 기술에 비하여 **발명이 불명확하게 되는 것이 아닙니다.**

따라서 위 피고 주장도 이유 없습니다.

바. 이 사건 특허발명에는 신규사항 추가의 무효사유가 없습니다.

피고는 이 사건 특허발명의 ‘TTL 수치범위’와 ‘F# 수치범위’, 그리고 ‘제2 및 제3 렌즈 요소의 합성 굴절력 구성’은 출원경과 중에 보정에 의해 추가된 구성이므로, 신규사항 추가에 해당한다고 주장합니다(2021. 5. 28.자 피고 준비서면 11면).

그러나 위 피고 주장은 이유 없습니다.

이 사건 특허발명의 TTL과 F#는 우선권출원 명세서에 기재된 사항의 범위 내에 있습니다.

구체적으로 우선권출원 명세서 2면 11-13행에는 ‘TTL is smaller than the EFL’는 ‘and’라는 접속 조사와 함께 ‘the TTL/EFL ratio is smaller than 0.9’와 병행하여 기재되어 있습니다.

> The effective focal length of the lens assembly is marked EFL and the total track length on an optical axis between the object-side surface of the first lens element and the electronic sensor is marked TTL. In all embodiments, TTL is smaller than the EFL and the TTL/EFL ratio is smaller than 0.9. In an embodiment, the TTL/EFL ratio

[을 제7호증 2면]

우선권출원 명세서는 ’TTL < EFL’및 ‘TTL/EFL < 0.9’를 모두 포함하고 있으므로 우선권 출원 원문은 ‘TTL/EFL < 1.0 을 명시적으로 개시하고 있는 것입니다.

한편 우선권출원 명세서에도 EFL 수치들(6.9 mm, 7 mm, 6.84 mm)[16], TTL/EFL < 1.0 구

16

을 제7호증 6, 8, 10면
Embodiment **100** provides a field of view (FOV) of 44 degrees, with EFL = 6.90 mm, F# = 2.80 and TTL of 5.904 mm. Thus and advantageously, the ratio TTL/EFL = 0.855. Advantageously, the Abbe number of the first, third and fifth lens element is

성이 기재되어 있으므로 TTL ≤ 6.5mm도 위 수치범위 내의 구성입니다.

특허출원서에 최초로 첨부된 특허청구범위를 보더라도 청구항 10은 "렌즈 조립체는 3.2보다 작은 F 번호를 갖는 것"이라고 기재하고 있고(을 제3호증의1 22면), 상세한 설명도 "F# < 3.2" 및 각 실시예 "F#= 2.80, 2.86, 2.80"을 제시하고 있으므로(갑 제3호증 [0009], [0020], [0026], [0032]) , F# < 2.9는 특허출원서에 최초로 첨부된 특허청구범위의 수치범위 내의 것이 명백합니다.

【청구항 10】 제1항에 있어서, 상기 렌즈 조립체는 3.2보다 작은 F 번호를 갖는 것임을 특징으로 하는 광학 렌즈 조립체.

[을 제3호증의1 22면]

[0009]	TTL은 제1 렌즈 요소의 물체-측 표면과 이미지 센서 사이의 광축 상의 거리로 정의된다. "EFL"는 그것의 통상적인 의미를 갖는다. 모든 실시 예에서, TTL은 EFL보다 작으며, 즉 TTL/EFL 비율이 1.0보다 작다. 일부 실시 예에서, TTL/EFL 비율은 0.9 미만이다. 일 실시 예에서, TTL/EFL의 비율은 대략 0.85이다. 모든 실시 예에서, 상기 렌즈 조립체는 F 번호, F#<3.2를 갖는다. 일 실시 예에서, 제1 렌즈 요소의 초점 길이 f1는 TTL/2보다 작고, 제
[0020]	실시 예(100)는 EFL = 6.90 mm, F# = 2.80 및 5.904 mm의 TTL을 갖는 44도(°)의 시야(FOV)를 제공한다. 따라
[0026]	실시 예(200)는 43.48° 의 FOV, EFL = 7mm, F# = 2.86 및 TTL = 5.90mm를 제공한다. 따라서 바람직하게는, 비
[0032]	실시 예(300)는 44° 의 FOV, EFL = 6.84 mm, F# = 2.80 및 TTL = 5.904 mm를 제공한다. 따라서 바람직하게는,

[갑 제3호증 단락 [0009], [0020], [0026], [0032]]

Embodiment **200** provides a FOV of 43.48 degrees, with EFL = 7 mm, F# = 2.86 and TTL = 5.90mm. Thus and advantageously, the ratio TTL/EFL = 0.843.
Embodiment **300** provides a FOV of 44 degrees, EFL = 6.84 mm, F# = 2.80 and TTL = 5.904 mm. Thus and advantageously, the ratio TTL/EFL = 0.863. Advantageously,

우선권출원 명세서{을 제7호증 2면 13줄~3면 5줄(원문), 29면 14줄~30면 13줄(번역문)}에도 이 사건 특허의 상세한 설명 단락 [0009] 내지 [0011]에 대응되는 기술내용이 기재되어 있습니다. 따라서 제2 및 제3 렌즈 요소의 합성 굴절력 구성'도 최초 명세서 등에 기재되어 있는 것입니다.

[0009] TTL은 제1 렌즈 요소의 물체-측 표면과 이미지 센서 사이의 광축 상의 거리로 정의된다. "EFL"는 그것의 통상적인 의미를 갖는다. 모든 실시 예에서, TTL은 EFL보다 작으며, 즉 TTL/EFL 비율이 1.0보다 작다. 일부 실시 예에서, TTL/EFL 비율은 0.9 미만이다. 일 실시 예에서, TTL/EFL의 비율은 대략 0.85이다. 모든 실시 예에서, 상기 렌즈 조립체는 F 번호, F#<3.2를 갖는다. 일 실시 예에서, 제1 렌즈 요소의 초점 길이 f1는 TTL/2보다 작고, 제1, 제3 및 제5 렌즈 요소들 각각은 50 이상의 아베 수("Vd")를 갖고, 제2 및 제4 렌즈 요소들 각각은 30보다 작은 아베 수를 가지며, 제1 공기 간격은 d2/2보다 작고, 제3 공기 간격은 TTL/5보다 크고, 제4 공기 간격은 1.5d5보다 작다. 일부 실시 예에서, 상기 렌즈 요소들의 표면은 비구면일 수 있다.

[0010] 여기에 개시된 광학 렌즈 조립체에서, 양의 굴절력을 가진 제1 렌즈 요소는 렌즈 시스템의 TTL이 양호하게 감소될 수 있도록 하여준다. 제1, 제2 및 제3 렌즈 요소들 및 그들 사이의 상대적으로 짧은 거리의 조합 설계는, 긴 EFL과 짧은 TTL을 가능하게 한다. 동일한 조합은 제2 렌즈 요소에 대한 고 분산(저 Vd) 및 제1 및 제3 렌즈 요소에 대한 저 분산(고 Vd)과 함께, 또한 색수차를 줄이는데 도움을 준다. 특히, 비율 TTL/EFL<1.0 및 최소 색수차는 조건 1.2x|f3|>|f2|>1.5xf1을 충족함으로써 얻어지고, 여기서 'f'는 렌즈 요소의 유효 초점 길이이고, 부호 1, 2, 3, 4, 5는 렌즈 요소의 번호를 나타낸다.

[0011] 상기 제3 및 제4 렌즈 요소들 사이의 비교적 큰 거리와, 제4 및 제5 렌즈 요소들의 조합된 설계는 이미지 면에 모든 시야의 초점들을 가져오는 데에 도움을 준다. 또한, 제4 및 제5 렌즈 요소들은 서로 다른 분산을 갖고, 각각 양과 음의 굴절력을 갖기 때문에, 그것들은 색수차를 최소화하는데 도움을 준다.

[갑 제3호증 단락 [0009] 내지 [0011]]

렌즈 조립체의 유효 초점 거리는 EFL로 표시되고, 제1 렌즈 요소의 물체-측 표면과 전자 센서 사이의 광축 상의 총 트랙 거리는 TTL로 표시된다. 모든 실시 예에서, TTL은 EFL보다 작고 TTL/EFL 비율이 0.9보다 작다. 일 실시 예에서, TTL/EFL의 비율은 대략 0.85이다. 모든 실시 예에서, 상기 렌즈 조립체는 F 번호, F#<3.2를 갖는다. 일 실시 예에서, 제1 렌즈 요소의 초점 길이 f1는 TTL/2보다 작고, 제1, 제3 및 제5 렌즈 요소들 각각은 50 이상의 아베 수("Vd")를 갖고, 제2 및 제4 렌즈 요소들 각각은 30보다 작은 아베 수를 가지며, 제1 공기 간격은 d_2/2보다 작고, 제3 공기 간격은 TTL/5보다 크고, 제4 공기 간격은 d_5/2보다 작다.

일부 실시 예에서, 상기 렌즈 요소들의 표면은 비구면일 수 있다. 여기에 개시된 광학 렌즈 조립체에서, 양의 굴절력을 가진 제1 렌즈 요소는 광학 렌즈 시스템의 TTL이 양호하게 감소될 수 있도록 하여준다. 제1, 제2 및 제3 렌즈 요소들 및 그들 사이의 상대적으로 짧은 거리의 조합 설계는, 긴 EFL과 짧은 TTL을 가능하게 한다. 동일한 조합은 제2 렌즈 요소에 대한 고 분산(저 아베 수) 및 제1 및 제3 렌즈 요소에 대한 저 분산(고 Vd)과 함께, 또한 색수차를 줄이는데 도움을 준다. 특히, 비율 TTL/EFL<0.9 및 최소 색수차는 조건 1.2x｜f3｜>｜f2｜>1.5xf1을 충족함으로써 얻어지고, 여기서 "f"는 렌즈 요소의 유효 초점 길이이고, 부호 1, 2, 3, 4, 5는 렌즈 요소의 번호를 나타낸다. 【0011】 상기 제3 및 제4 렌즈 요소들 사이의 비교적 큰 거리와, 제4 및 제5 렌즈 요소들의 조합된 설계는 이미지 면에 모든 시야의 초점들을 가져오는데에 도움을 준다. 또한, 제4 및 제5 렌즈 요소들은 서로 다른 분산을 갖고, 각각 양과 음의 굴절력을 갖기 때문에, 그것들은 색수차를 최소화하는데 도움을 준다.

[을 제7호증 29면 14줄~30면 13줄]

이 사건 심결도 정정사항 1 내지 13은 이 사건 특허의 명세서 또는 도면에 기재된 사항의 범위 내에서 이루어진 것이라고 판단하였고, 이는 지극히 타당합니다.[17]

결국 피고 주장은 모두 이유 없고, 이 사건 정정발명에는 신규사항 추가의 무효사유가 없습니다.

17

갑 제1호증 심결문 13면
정정사항 1 내지 13은 특허청구범위를 감축한 경우에 해당하고, 이 사건 특허발명의 명세서 또는 도면에 기재된 사항의 범위에서 이루어진 것이며, 위 정정사항 1 내지 13으로 인하여 이 사건 특허발명의 목적이나 효과에 어떠한 변경도 없어 이 사건 특허발명이 실질적으로 확장하거나 변경하였다고 볼 수 없으므로 이 사건 정정청구는 특허법 제133조의2 제1항 및 제4항에서 준용하는 같은 법 제136조제1항, 제3항 및 제4항을 충족하는 적법한 정정으로 인정된다.

사. 이 사건 정정발명은 선행발명 1 단독에 의하여 또는 선행발명 1과 주지관용기술(을 제5, 6호증)의 결합에 의하여 진보성이 부정되지 않습니다.

피고는 이 사건 정정발명은 선행발명 1 단독에 의하여 또는 선행발명 1과 주지관용기술(을 제5, 6호증)의 결합에 의하여 진보성이 부정된다고 주장합니다(2021. 2. 8.자 피고 준비서면).

그러나 피고 주장은 모두 이유 없습니다.

(가) 선행발명 1은 실시불가능하고 통상의 기술자가 그 기술적 내용을 파악하기 어려우므로, 진보성 판단의 대비대상이 될 수 없습니다.

2021. 6. 3.자 원고 준비서면 3 내지 6면에서 설명드린 바와 같이 선행발명 1의 실시예 2의 제2 촬상광학계(LN2)는 제4 렌즈의 상측 면과 제5 렌즈의 물체측 면이 공간적으로 겹치도록 구성되어 있어 실제 구현이 불가능합니다. 이는 피고도 인정하고 있습니다.

또한 통상의 기술자가 위 구성을 실현 가능한 발명으로 파악하기도 어렵습니다.

따라서 선행발명 1은 진보성 판단에서 대비대상이 될 수 없습니다.

(나) 설령 선행발명 1이 대비대상이 될 수 있다고 하더라도 이 사건 정정발명은 선행발명 1에 의하여 진보성이 부정되지 않습니다.

이 사건 정정발명은 선행발명 1과 '제1 렌즈 요소의 초점 길이(f1)는 TTL/2보다 작은 구성', '제1 렌즈 요소는 볼록한 물체-측 표면과 볼록한 이미지-측 표면을 갖는 구성', 및 '렌즈 조립체의 F#는 2.9보다 작은 구성'의 차이가 있으며, 이는 양 당사자 간에 다툼이 없습니다.

피고는 선행발명 1의 단락 [0019]에 기재된 "1.0<fFw/fFm < 1.5 - 조건식 (1)"을 기초로 '제1 렌즈 요소의 초점 길이(f1)는 TTL/2보다 작은 구성'을 도출할 수 있고, '제1

렌즈 요소는 볼록한 물체-측 표면과 볼록한 이미지-측 표면을 갖는 구성'에 대하여는 아무런 기술적 의미를 가지지 않는다고 주장하며, '렌즈 조립체의 F#는 2.9보다 작은 구성'에 대하여는 아무런 기술적 실체를 가지지 못하는 무의미한 수치한정이라고 주장합니다.

그러나 2021. 6. 3.자 원고의 준비서면 6 내지 14면에서 설명드린 바와 같이 피고의 주장은 부당합니다.

1) '제1 렌즈 요소의 초점 길이(f1)는 TTL/2보다 작은 구성'에 대하여

피고가 주장하는 선행발명 1의 단락 [0019]에는 다음과 같은 기재가 있습니다.

2021. 2. 8.자 피고 준비서면 12면
[0019] "1.0<fFw/fFm<1.5 … (1) 단, fFw: 제1 촬상 광학계에 있어서의 제1 렌즈와 제2 렌즈의 합성 초점 거리, fFm: 제2 촬상 광학계에 있어서의 제1 렌즈와 제2 렌즈의 합성 초점 거리 이다." [0024] "조건식 (1)의 하한을 상회하는 것은, 제2 촬상 광학계의 전군의 초점 거리가 제1 촬상 광학계의 전군의 초점 거리보다도 짧은(즉 파워가 강한) 것을 의미한다. 즉, 제2 촬상 광학계는 전체 계의 초점 거리가 상대적으로 길기 때문에, 전체적으로는 양의 파워가 약해지지만, 그에 반하여, 전체 계의 초점 거리가 짧은 제1 촬상 광학계의 전군보다도 파워를 강하게 하는 조건을 하한으로 규정하고 있다. 이 조건식 (1)을 만족시킴으로써, 제2 촬상 광학계의 텔레포토 경향을 강하게 할 수 있기 때문에, 장치로서의 전체 길이를 작게 하는 효과가 얻어진다." [을 제4호증 [0019] 및 [0024] 단락의 번역문]

그런데 <u>위 조건식 (1)은 제1 렌즈와 제2 렌즈의 합성 초점 거리에 관한 것이지, 제1 렌즈의 초점 거리에 관한 것이 아닙니다</u>.

예를 들어 피고가 언급한 선행발명 1의 명세서(을 제4호증 단락 [0019] 및 [0024]), 위 명세서 중 노란색 표시 부분)도 제1렌즈(L1)와 제2렌즈(L2)의 합성 초점거리만을 개시하고 있으며, 제1렌즈(L1)의 초점거리를 분리하여 기재하고 있지 않습니다.

또한 위 선행발명 1의 위 단락은 f1을 TTL/2보다 작게 하는 구성을 기재하고 있지않습니다. 오히려 선행발명 1에 개시된 실시예는 모두 f1이 TTL/2보다 큰 값을

갖고 있습니다(아래 을 제4호증 단락 [0076] 노란색 부분 참조[18]).

을 제4호증 [0076] 표 1

		실시예1		실시예2	
		LN1	LN2	LN1	LN2
전체 계의 초점 거리 [mm]	fw 또는 fm	2. 73	4. 32	3. 70	5. 51
Fno	FNOw 또는 FNOm	4. 00	4. 00	3. 00	4. 00
렌즈 전체 길이(무한시)[mm]	TLw 또는 TLm	3. 04	3. 65	4. 45	4. 91
최대상 높이 [mm]	2Y'	5. 12	5. 12	5. 80	5. 80
전체 화각[deg]	2ωw 또는 2ωm	86. 32	61. 28	76. 18	55. 52
L1 초점 거리[mm]	f1w 또는 f1m	2. 60	2. 10	2. 47	2. 54

2) '제1 렌즈 요소는 볼록한 물체-측 표면과 볼록한 이미지-측 표면을 갖는 구성'에 대하여

피고는 제1 렌즈 요소의 이미지-측 표면이 오목한지 볼록한지 이 사건 정정발명과 관련하여 아무런 기술적 의미를 가지지 않으므로, 위 구성은 통상의 기술자가 적의 선택하여 용이하게 도출할 수 있다고 주장합니다.

그러나 렌즈의 형태에 따라 렌즈의 초점거리 등 구성요소가 상이해지며 이로 인해 렌즈 시스템의 효과가 상이해지는 것은 렌즈 시스템의 통상의 기술자에게 자명한 사실입니다. 따라서 렌즈 시스템의 설계에 있어서 렌즈의 형태는 기술적 의미를 갖는 것은 자명합니다.

선행발명 1의 망원 광학계들은 모두 제1 렌즈 요소의 이미지-측 표면이 오목한 특징적인 구성을 채택하고 있으며, 이와 달리 제1 렌즈 요소의 이미지-측 표면을 볼록한 형태로 변경할 만한 어떠한 동기도 제시되어 있지 않습니다.

3) '렌즈 조립체의 F#는 2.9보다 작은 구성'에 대하여

피고는 "F#가 2.9보다 작"은 구성에 대하여 아무런 기술적 실체를 가지지 못하는 무의미한 수치한정이라고 주장합니다.

[18] 을 제4호증 단락 [0076] 표1에 따르면, 실시예 1에서 f1은 2.1로 TTL/2인 1.825(=3.65/2)보다 크며, 실시예 2는 f1은 2.54로 TTL/2인 2.455(=4.91/2)보다 큽니다.

그러나 앞서 말씀드린 바와 같이, F#의 요건에서 최소한의 광량을 한정하는 구성은 고화질 구현을 위해 충분히 많은 광량이 요구됨을 고려하여 채택된 구성이고, 이는 종래 짧은 초점거리를 갖는 광각 광학계와는 달리 '소형 망원 렌즈 조립체'에 관한 이 사건 정정발명의 특징적인 구성입니다.

선행발명 1도 청구항 7[19]에서 F#를 특징적인 구성요소로 기재하고 있습니다.

따라서 피고 주장은 이유 없습니다.

한편 선행발명 1에는 선행발명 1은 '<u>제1 촬상 광학계보다 제2 촬상 광학계 쪽을 어둡게 하는 편이 전체의 소형화를 달성하는 데 유리하다</u>'라고 기재하고 있고(을 제4호증 단락 [0038]), 각 실시예에서의 제1 촬상 광학계(광각)와 제2 촬상 광학계(망원)의 F#의 구체적인 값이 기재되어 있습니다(을 제4호증 단락 [0076]).

을 제4호증 단락 [0037] 및 [0038]

19

을 제4호증 30면
【청구항 7】 제1항 내지 제6항 중 어느 한 항에 있어서, 이하의 조건식 (5)를 만족시키는 것을 특징으로 하는 촬상 장치; 0.6<FNOw/FNOm<1.3 … (5) 단, FNOw: 제1 촬상 광학계의 F 넘버, FNOm: 제2 촬상 광학계의 F 넘버 이다.

【0037】

이하의 조건식 (5)를 만족시키는 것이 바람직하다.

0.6<FNOw/FNOm<1.3 … (5)

단,

FNOw: 제1 촬상 광학계의 F 넘버,

FNOm: 제2 촬상 광학계의 F 넘버

이다.

【0038】

전환 시에 F 넘버가 크게 상이하면, 흐려짐의 인상이 크게 바뀌게 되어, 사용자에게 있어서는 부자연스러워지므로, F 넘버는 조건식 (5)를 만족시키도록 제1, 제2 촬상 광학계에서 가까운 편이 바람직하다. 제1 촬상 광학계보다도 제2 촬상 광학계의 쪽을 어둡게 하는 편이 전체의 소형화를 달성하는 데 있어서 유리하게 된다.

을 제4호증 단락 [0076]

		실시예1		실시예2	
		LN1	LN2	LN1	LN2
전체 계의 초점 거리 [mm]	fw 또는 fm	2. 73	4. 32	3. 70	5. 51
Fno	FNOw 또는 FNOm	4. 00	4. 00	3. 00	4. 00
렌즈 전체 길이(무한시)[mm]	TLw 또는 TLm	3. 04	3. 65	4. 45	4. 91
최대상 높이 [mm]	2Y'	5. 12	5. 12	5. 80	5. 80
전체 화각[deg]	2ωw 또는 2ωm	86. 32	61. 28	76. 18	55. 52

선행발명 1의 단락 [0037]에 기재된 "0.6<FNOw/FNOm<1.3 … (5)"은 광각 광학계와 망원 광학계 사이의 F# 비율에 관한 것으로서, 전환 시에 흐려짐의 인상이 크게 바뀌어 부자연스러운 것을 방지하기 위하여 두 광학계의 F#을 일정 범위 내에 있도록 한 것입니다.

이때 선행발명 1이 제시하는 2개의 실시예에서 광각 광학계(LN1)의 F#는 3.00 또는 4.00으로 다른 값을 갖는데 반하여, 망원 광학계(LN2)의 F#는 4.00으로 동일합니다. 즉 선행발명 1은 두 광학계 사이의 F# 비율에 있어서 광각 광학계의 F#를 변경할 동기는 가지고 있을지언정 망원 광학계의 F#를 변경(예컨대, 4.00보다 작게)

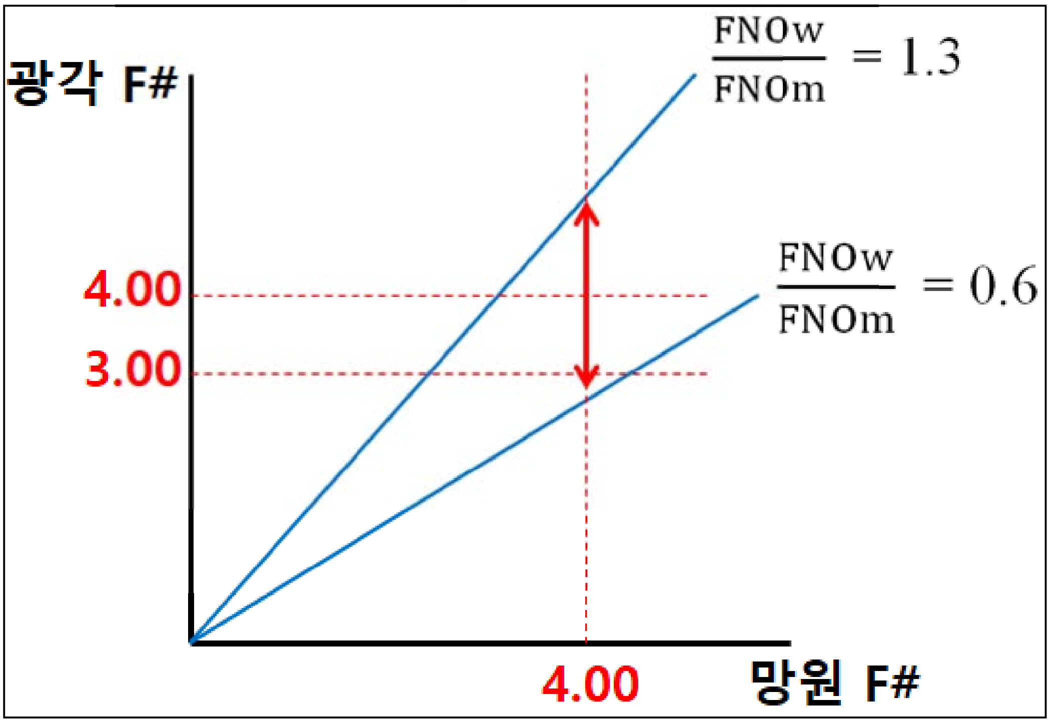
하려는 동기를 제시하지는 못하고 있는 것입니다.

선행발명 1은 망원 광학계의 F#를 변경하려는 노력보다는 망원 광학계의 F#는 4.00으로 설계하고, 흐려짐의 인상을 고려하여 광각 광학계의 F#를 3.00 또는 4.00으로 한 것에 불과합니다(을 제4호증 단락 [0038] 참조).

전환 시에 F 넘버가 크게 상이하면, 흐려짐의 인상이 크게 바뀌게 되어, 사용자에게 있어서는 부자연스러워지므로, F 넘버는 조건식 (5)를 만족시키도록 제1, 제2 촬상 광학계에서 가까운 편이 바람직하다. 제1 촬상 광학계보다도 제2

[을 제4호증 단락[0038]]

이와 같이 선행발명 1은 망원 광학계의 F#를 낮추려는 동기를 제공하는 것이 아니라, 망원 광학계의 F#인 4.00을 기초로 광각 광학계의 F#를 조절하여 광각 광학계와 망원 광학계의 비율을 0.6~1.3의 범위로 조정하는 것입니다.



반면 이 사건 특허발명에서 F#을 2.9 미만으로 함으로써 얻어지는 효과는 선행발명 1에서는 예상하기 어려운 이질적 효과에 해당합니다. 선행발명 1에서는 이러한 효과를 얻기 위하여 망원 광학계의 F#을 변경할 동기를 찾아보기 어렵습니다.

결국 통상의 기술자는 선행발명 1로부터 '렌즈 조립체의 F#는 2.9보다 작은 구성'을 도출할 수 없습니다.

(다) 이 사건 정정발명은 선행발명 1과 을 제5, 6호증의 선행기술의 결합에 의하여 진보성이 부정되지 않습니다.

2021. 2. 8.자 피고의 준비서면 3 내지 18면에서 피고는 위 차이점 1 내지 3에 해당하는 구성을 각각 분해한 후, 분해된 개별 구성요소들이 을 제5, 6호증의 선행기술에 개시되어 있다거나, 그러한 개별 구성요소들이 주지관용기술에 해당한다고 주장합니다.

그러나 2021. 6. 3.자 원고의 준비서면 14 내지 32면에서 설명드린 바와 같이 피고 주장은 이 사건 정정발명에 기재된 구성간 유기적 결합관계를 전혀 고려하지 않은 것으로, 피고의 주장과는 달리 일반 카메라용 렌즈 시스템과 휴대 단말기용 소형 망원 렌즈 조립체는 렌즈 시스템 자체가 상이하여 서로 결합할 수 없고, 피고가 주장하는 구성은 주지관용기술에 해당하지도 않습니다.

	피고의 주장			피고 주장의 부당성
	f1<TTL/2	제1 렌즈요소의 양-측 표면 볼록	F#<2.9	
선행발명1	X	X	X	구성요소를 개시하고 있지 않음
을제5호증의2	o	o	-	F#가 2.9를 현저히 초과함 TTL ≤ 6.5 mm 이 아닌 일반 대형 카메라 망원 렌즈로 이 사건 특허와 결합할 수 없음
을제5호증의3	o	o	-	F#가 2.9를 현저히 초과함

				TTL ≤ 6.5 mm 이 아닌 일반 대형 카메라 망원 렌즈로 이 사건 특허와 결합할 수 없음
을제5호증의4	o	o	-	F#가 2.9를 현저히 초과함 TTL ≤ 6.5 mm 이 아닌 일반 대형 카메라 망원 렌즈로 이 사건 특허와 결합할 수 없음
을제6호증의1	-	-	o	TTL/EFL < 1 이 아닌 광각 렌즈로 이 사건 특허와 결합할 수 없음
을제6호증의2	-	-	o	f1 < TTL/2 이 아님 일반 대형 카메라 망원 렌즈로 이 사건 특허와 결합할 수 없음
을제6호증의3	-	-	o	f1 < TTL/2 이 아님 일반 대형 카메라 망원 렌즈로 이 사건 특허와 결합할 수 없음
을제6호증의4	-	-	o	TTL/EFL < 1 이 아닌 광각 렌즈로 이 사건 특허와 결합할 수 없음
을제6호증의5	-	-	o	TTL/EFL < 1 이 아닌 광각 렌즈로 이 사건 특허와 결합할 수 없음

먼저 피고의 주장은 청구항에 기재된 복수의 구성을 분해한 후 각각 분해된 개별 구성요소들이 공지된 것인지 여부만을 따지는 것으로서 진보성 판단에 관한 대법원 판례에 정면으로 반합니다.[20]

20

대법원 2007. 11. 29. 선고 2006후2097 판결
어느 특허발명의 특허청구범위에 기재된 청구항이 복수의 구성요소로 되어 있는 경우에는 각 구성요소가 유기적으로 결합한 전체로서의 기술사상이 진보성 판단의 대상이 되는 것이지 각 구성요소가 독립하여 진보성 판단의 대상이 되는 것은 아니므로, 그 특허발명의 진보성 여부를 판단함에 있어서는 청구항에 기재된 복수의 구성을 분해한 후 각각 분해된 개별 구성요소들이 공지된 것인지 여부만을 따져서는 안 되고, 특유의 과제 해결원리에 기초하여 유기적으로 결합된 전체로서의 구성

또한 피고가 제출한 을 제6호증의1도 일반 대형 카메라용 렌즈 시스템의 설계와 휴대 단말기용 소형 렌즈 조립체의 설계는 분명하게 다르다고 언급하고 있고,[21] 일반 카메라의 렌즈 형태는 휴대 단말기용으로는 적합하지 않으므로 휴대 단말기용 렌즈 조립체는 일반 카메라의 렌즈 시스템에 기초한 것이 아니라 새롭게 설계를 해야 합니다.

나아가 몇 개의 선행문헌에 개시되었다는 사정만으로 주지관용기술이라고 인정될 수 없고, 유기적으로 결합된 전체 렌즈 조립체에서 일부 구성만을 발췌하여 해당 구성이 주지관용기술이라고 볼 수도 없습니다.[22]

결국 피고 주장은 모두 이유 없고, 이 사건 정정발명은 선행발명 1 단독에 의하여 또는 선행발명 1과 주지관용기술(을 제5 내지 6호증)과의 결합에 의하여 진보성이 부정될 수 없습니다.

아. 이 사건 정정발명은 출원일이 우선일로 소급되므로, 선행발명 2는 확대된 선출원의 선행발명이 될 수 없습니다.

피고는 2021. 2. 8.자 피고의 준비서면 19 내지 22면에서 이 사건 정정발명의 명세서는 우선권출원 명세서와 발명의 기술내용이 동일하지 않게 기재되어 있으므로, 그 출원일이 우선일로 소급될 수 없다고 주장합니다.

그러나 통상의 기술자는 출원 시의 기술상식에 비추어 보아 이 사건 특허발명의 TTL 및 F# 수치범위, "음의 광학력을 함께 갖는 한 쌍의 제2 및 제3 렌즈 요소들"이라는 구성은 모두 우선권출원 명세서 등에 기재되어 있는 것이라고 이해할 수 있습니다.

의 곤란성을 따져 보아야 할 것이며, 이 때 결합된 전체 구성으로서의 발명이 갖는 특유한 효과도 함께 고려하여야 한다(대법원 2007. 9. 6. 선고 2005후3277 판결 참조).

[21] 2021. 6. 3. 자 원고의 준비서면 17 내지 22면 참조
[22] 2021. 6. 3. 자 원고의 준비서면 23 내지 33면 참조

결국 이 사건 정정발명의 출원일이 우선일인 2013. 7. 4.로 소급되므로, 우선일이 2013. 10. 31.인 선행발명 2는 확대된 선출원의 선행발명이 될 수 없습니다.

4. 결 론

이상과 같이 피고 주장은 모두 이유 없고, 이 사건 정정발명에는 아무런 무효사유가 없습니다. 따라서 이 사건 심결을 취소하여 주시기 바랍니다.

참 고 자 료

1. 참고자료 1 과학백과사전 레스폰스함수 검색화면
1. 참고자료 2 OPPO X907 사양
1. 참고자료 3 후지쯔 Arrows ES IS12F 사양
1. 참고자료 4 화웨이 Ascend P1s 사양
1. 참고자료 5 애플 iPhone5 사양
1. 참고자료 6 삼성전자 갤럭시S4 매뉴얼
1. 참고자료 7 SONY 엑스페리아 Z 울트라 사양
1. 참고자료 8 삼성홈페이지 폴디드 렌즈 화면

첨 부 서 류

1. 위 참고자료 각 1통

2021. 8. 2.

원고 소송대리인

법무법인(유) 율 촌

담당변호사 최 정 열

담당변호사 정 상 태

담당변호사 이 한 결

담당변호사 김 하 영

특허법인 씨엔에스

담당변리사 손 원

담당변리사 황 우 택

담당변리사 이 의 훈

담당변리사 윤 병 훈

담당변리사 안 성 수

담당변리사 곽 인 영

특허법원 제 3 부 귀중